KinonLab

Manual

May 13, 2017

Introduction

KinonLab is a *Mathematica* application aimed at the investigation of a novel model of complex dynamical systems called a *kinetic automaton*, or *kinon* for short [1,2]. The application consists of a single file *kinonlab.cdf* which can be run in *Wolfram Mathematica* 9.0 or higher. It also can be run in a free *CDF Player* but without file functionality.

User interface

The user interface consists of a control panel and an output window comprising four panes and a bottom status line (Fig.1). A map pane serves for the visualization and adjustment of the kinetic map used for modulation. A view pane displays the image of the current state of the kinon network. The bottom row holds a histogram and plot panes described further.

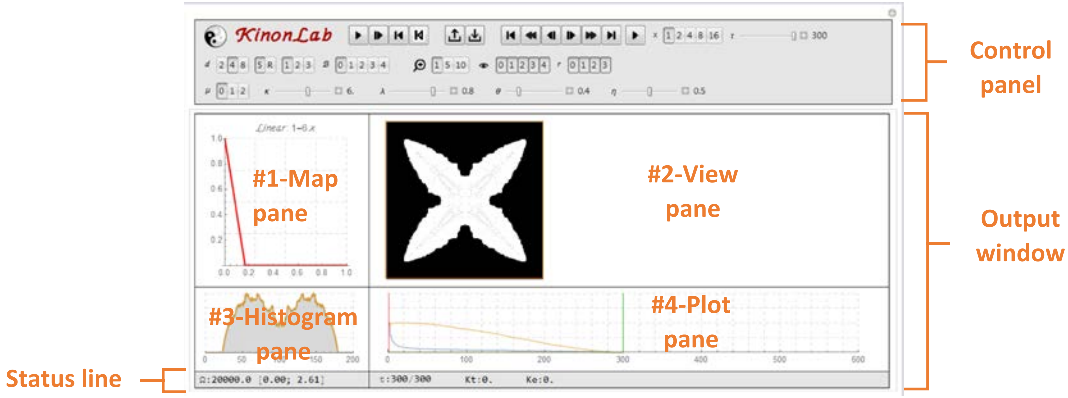


Figure 1. *Interface layout*

Control panel

The control panel comprises three rows of interactive controls for setting up and manipulation of all the parameters of the kinon network and the exploration of the results in either of three main modes:

1. **Evolution:** computing and caching of all successive states of the kinon network.
2. **Playback:** playing the cached results of computation forth and back.
3. **Script:** restoring a session from a script file.

In the evolutionary mode, the values of all parameters can be changed at any step and these changes are automatically recorded in a script, which can be saved in or loaded from a file.

The first row holds the buttons for step control (start, pause, resume) in any mode and navigation during playback (Fig.2). The current session can be either reset to default initial values of all parameters of resumed with the same ones.

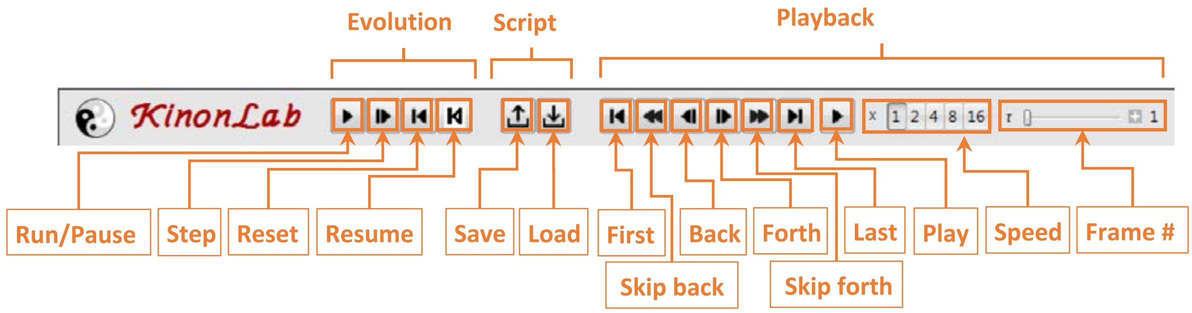


Figure 2. *1st row of the control panel*

The second row of the control panel holds the selectors for the initial configuration settings, visualization of the output window (Fig.3).

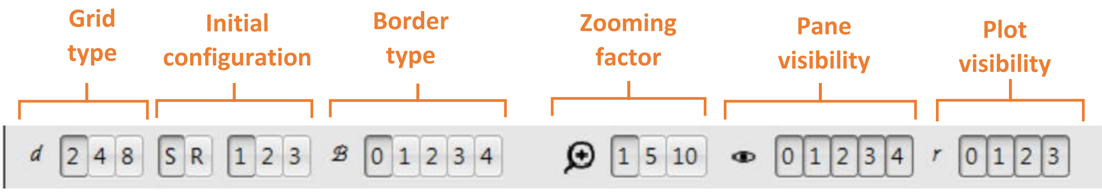


Figure 3. *2nd row of the control panel*

The kinon network is a set of kinons arranged in a regular grid, where all nodes have the same number of links. Currently, *KinonLab* supports only one- and two-dimensional square grids. In a one-dimensional case, the number of neighbors is equal to **2**, while in two dimensions it can be variable: **4** (Von Neumann neighborhood) or **8** (Moore neighborhood). The width of grid is equal to 200, so the total number of kinons in the kinon grid is equal to 200 for 1D and 40 000 (200x200) for 2D. The type of the grid is defined by the first selector.

The next two selectors define the category of the initial configuration (**S**ingular or **R**andom) and its type (**1**,**2** or **3**). In a singular initial configuration, only some (from 1 to 3) equally spaced kinons have the same non-zero initial storage values. Their sum is set to a half of the total number of kinons for the visualization of the uniform state as a grey color in a greyscale image. For a random configuration, the initial values of storage of all kinon are assigned randomly in one of the predefined ranges: [0.49,0.51] 1) (**1**), [0.25,0.75] (**2**), [0,1] (**3**).

By default, the border type is set to **0** (borderless). It means that the opposite border kinons are connected with each other, which corresponds to a ring in 1D or a torus in 2D. For the study of growth in a bounded space, there are four predefined border types, which can be selected via a dropdown menu: 1-square, 2-rhomb, 3-octagon, 4-circle (Fig.4).

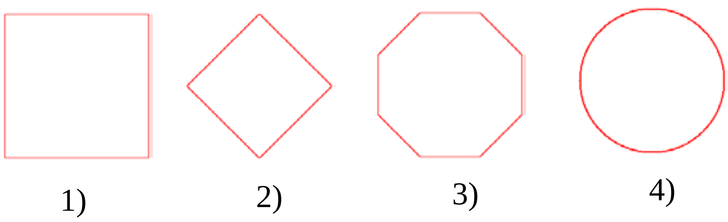


Figure 4. *Border types*

The next three selectors after a border type define some aspects of the content visualization in the output:

1. **Zooming:** magnification of the image in the view pane.
2. **Pane visibility:** switching on or off some (**1-4**) or all (**0**) panes in the output window.
3. **Plot visibility:** switching on or off some (**1-3**) or all (**0**) plots in the plot pane.

Switching off some or all panes or plots considerably accelerates the performance of computation.

The last third row of the control panel (Fig.5) holds the controls for the kinetic map type used by the modulator and corresponding filters of the encoder and decoder. These parameters can be changed at any step during evolution.

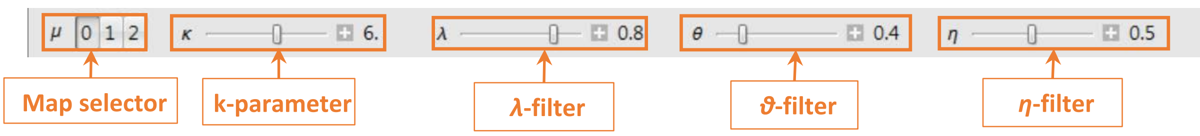
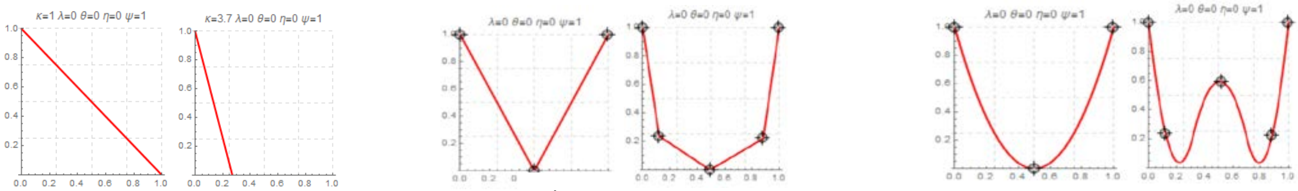


Figure 5. *3rd row of the control panel*

Output window

The output window is divided into four panes displaying a kinetic map, image of the current state of the kinon network, state histograms, and the plots of macrodynamic indices. The bottom line of the output window displays the key parameters of the current session.

The map pane displays the kinetic map used by a modulator which transforms input ranks into output rates. There are three types of the kinetic map: basic, piecewise and spline (Fig.6).



0) *Basic* 1) *Piecewise* 2) *Spline*

Figure 6. *Types of the kinetic map*

The basic map (**0**) corresponds to a function y=max[1-kx,0], where k equals to 1 by default and can be changed via the k-slider. Alternatively, the kinetic map can be defined interactively via a piecewise function (**1**) or a spline (**2**) using control points shown by the crossed circles on the plot. They can be added or deleted using Alt+Click and dragged around the pane with a mouse.

In a one-dimensional case (Fig.7), the view pane displays a space-time diagram of the kinon grid with a corresponding histogram of the current step marked by a green vertical line in the view and plot panes. The steps with altered parameters are marked by red vertical lines. The plot pane displays the history of two macrodynamic indices: turnover rate ***Kt*** shown in a peach color and exchange rate ***Ke*** shown in blue.

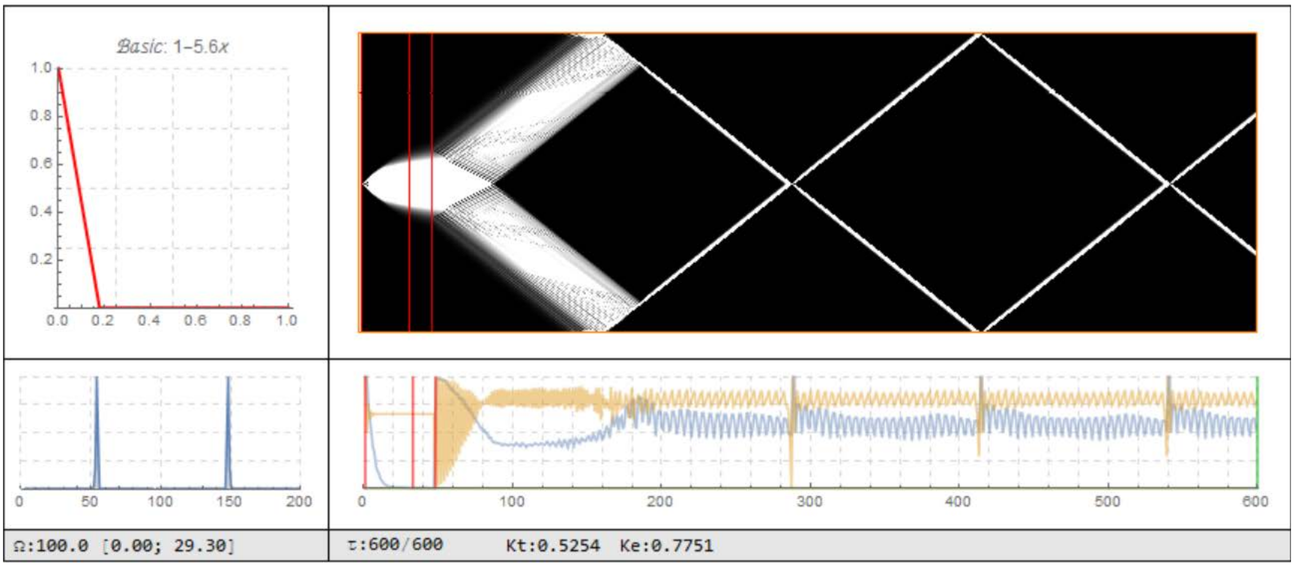


Figure 7. *Snapshot of the output window in a 1D case*

In a two-dimensional case (Fig.8), the view pane displays the image of the current step pf the kinon grid with corresponding two overlaid histograms. These histograms show the total values of kinons along x- and y-axes.

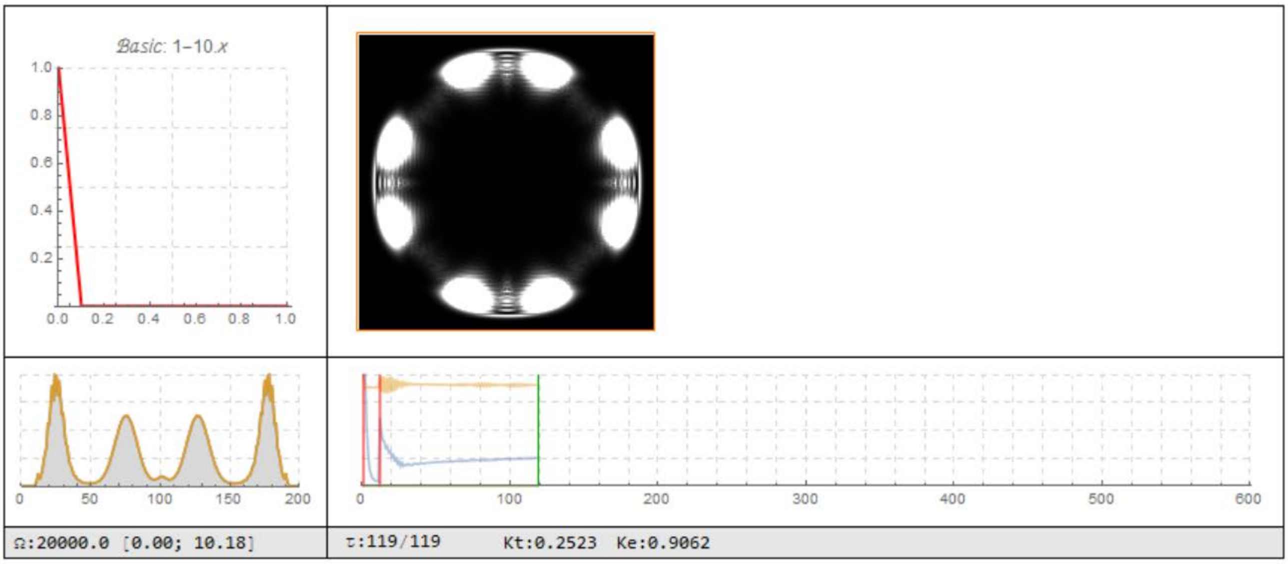


Figure 8. *Snapshot of the output window in a 2D case*

The bottom row of the output windows, called a status line, is used for monitoring the key parameters of the current session (Fig.9).

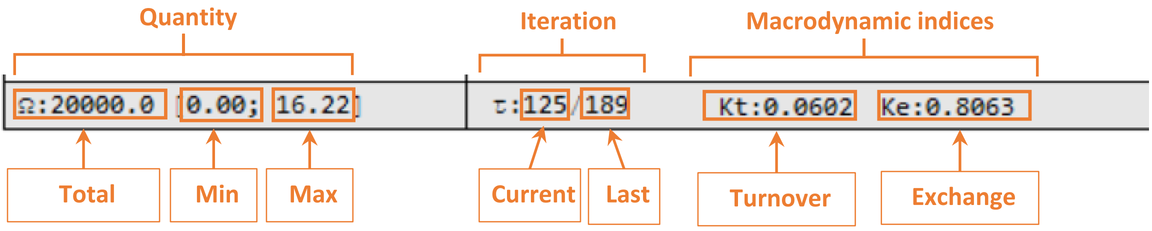


Figure 9. *Status line*

References

[1] Y. Shalygo, “The Kinetic Basis of Self-Organized Pattern Formation,” in Proceedings of the 14th International Conference on the Synthesis and Simulation of Living Systems (ALife 14), (H. Sayama, J. Rieffel, S. Risi, R. Doursat, and H. Lipson, eds.), Cambridge, MA: MIT Press, 2014 pp.665–672.

[2] Y. Shalygo, “The Kinetic Basis of Morphogenesis,” in Proceedings of the 13th European Conference on Artificial Life (ECAL 2015) York UK, Cambridge, MA: MIT Press, 2015, pp.122-129.