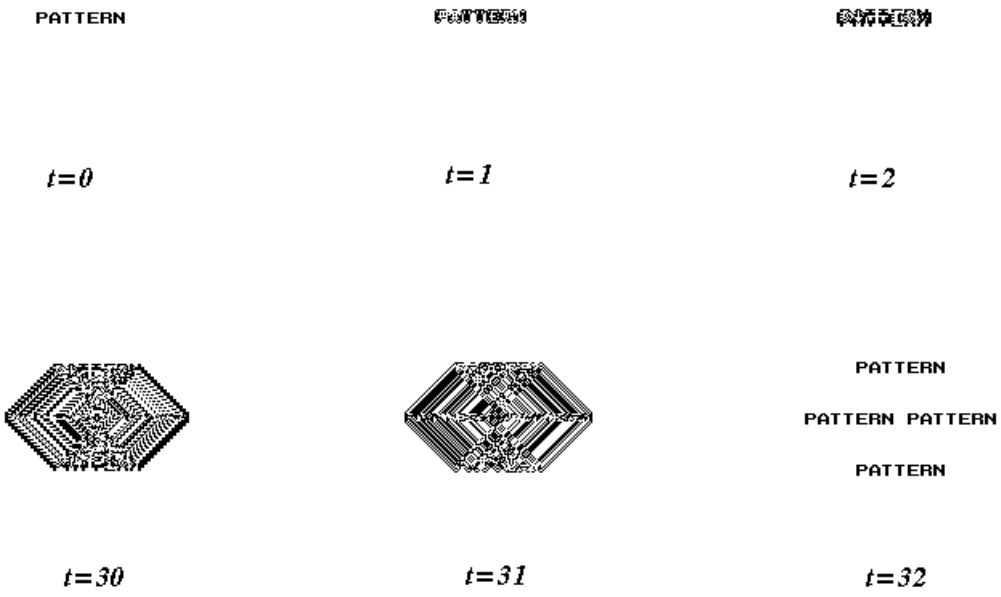
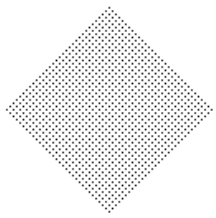


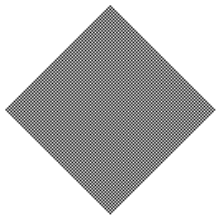
Fig. 1. Demonstration on the phenomenon of “self-replication”, found by Fredkin (1962?).

To illustrate that *every* configuration has an ability to reproduce itself, we use the word “PATTERN”, written with non-blank cells as an initial configuration (*t=0*). After 32 tacts only four identical copies of the initial configuration remain.

The rule of the CA above is quite simple: every cell of an infinite tesselation turns on, if and only if an odd number of its neighbours (top, down, left and right) were turned on at the previous tact; otherwise the cell turns off.

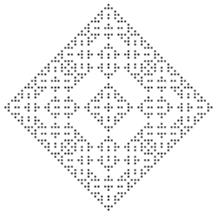
(a)

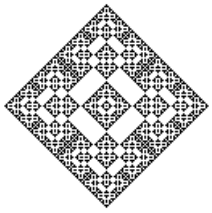




t=62 ***t=63*** ***t=64***

(b)

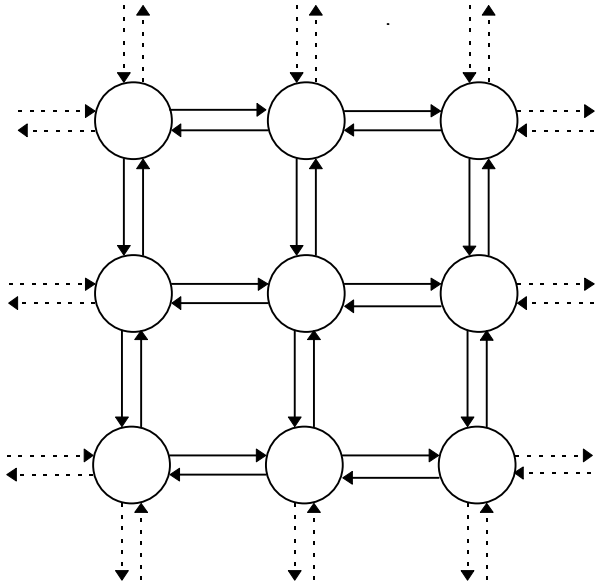




t=62 ***t=63*** ***t=64***

Fig. 2. Demonstration on an impresive difference of the dynamics of parity rules on a tesselation with four (a) and five (b) neighbours.
In both cases we have replicators (t=64), but why configurations before that (t=62, t=63) are looking more compex, when we include the central cell in the rules (case b)?

(a)



(b)

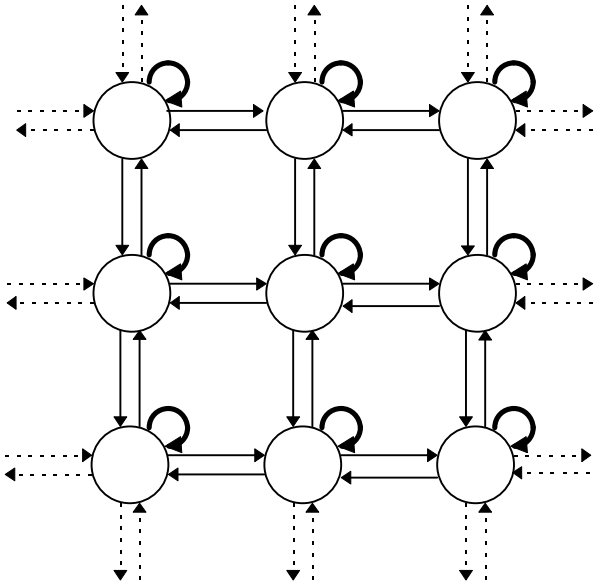


Fig. 3. CAs on a tessellation, presented as CAs on a homogeneous directed graph:

(a) Four neighbours, all links are indistinguishable;
(b) Five neighbours, loops are distinguishable from the other links.

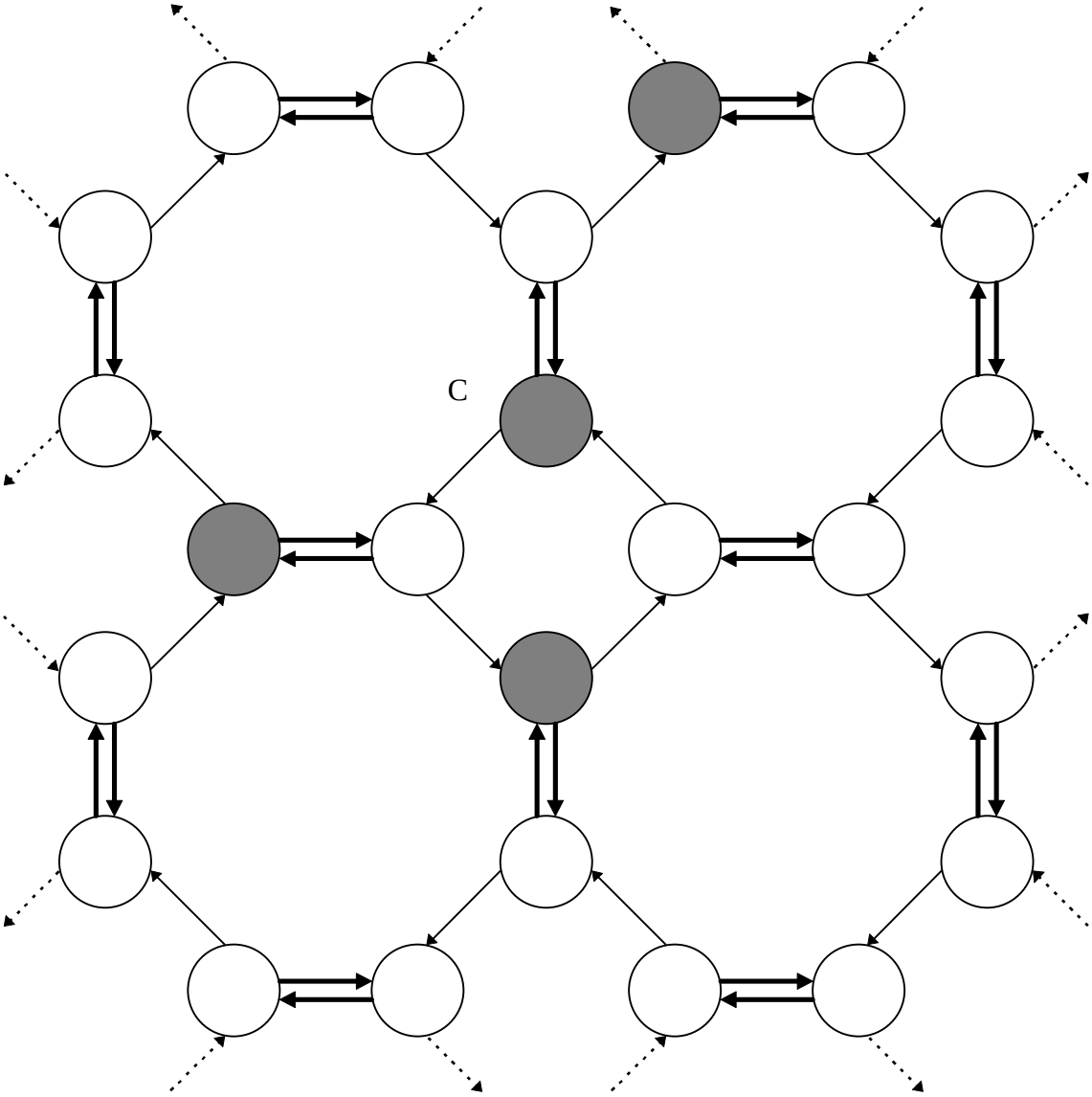


Fig. 4. CP-MOSAIC automaton, generation 2.

("Left" links are shown in bold, "right" – in normal style; the single nonblank cell in the initial configuration is marked as "C").

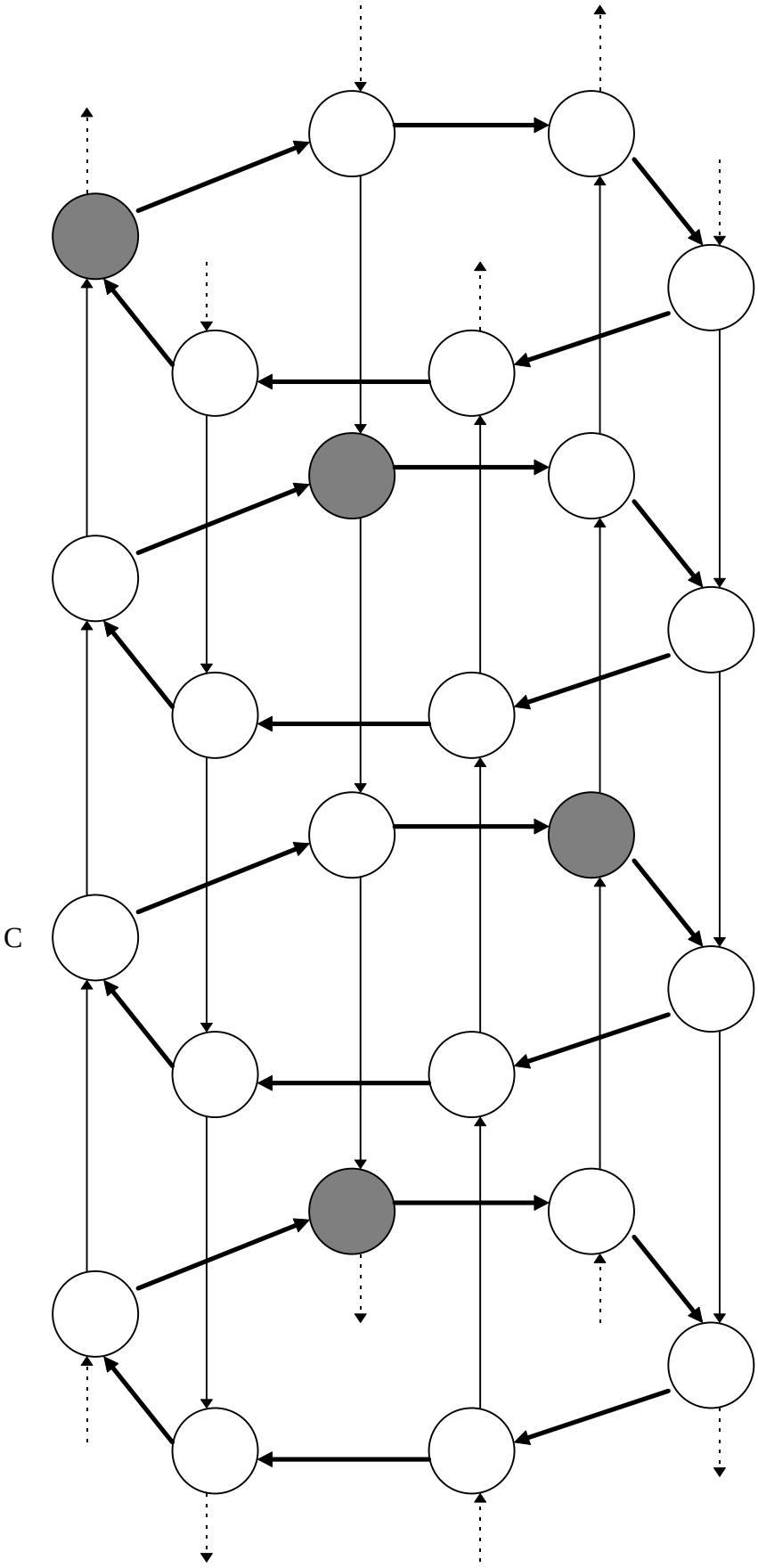


Fig. 5. CP-CYLINDER (6), generation 2.

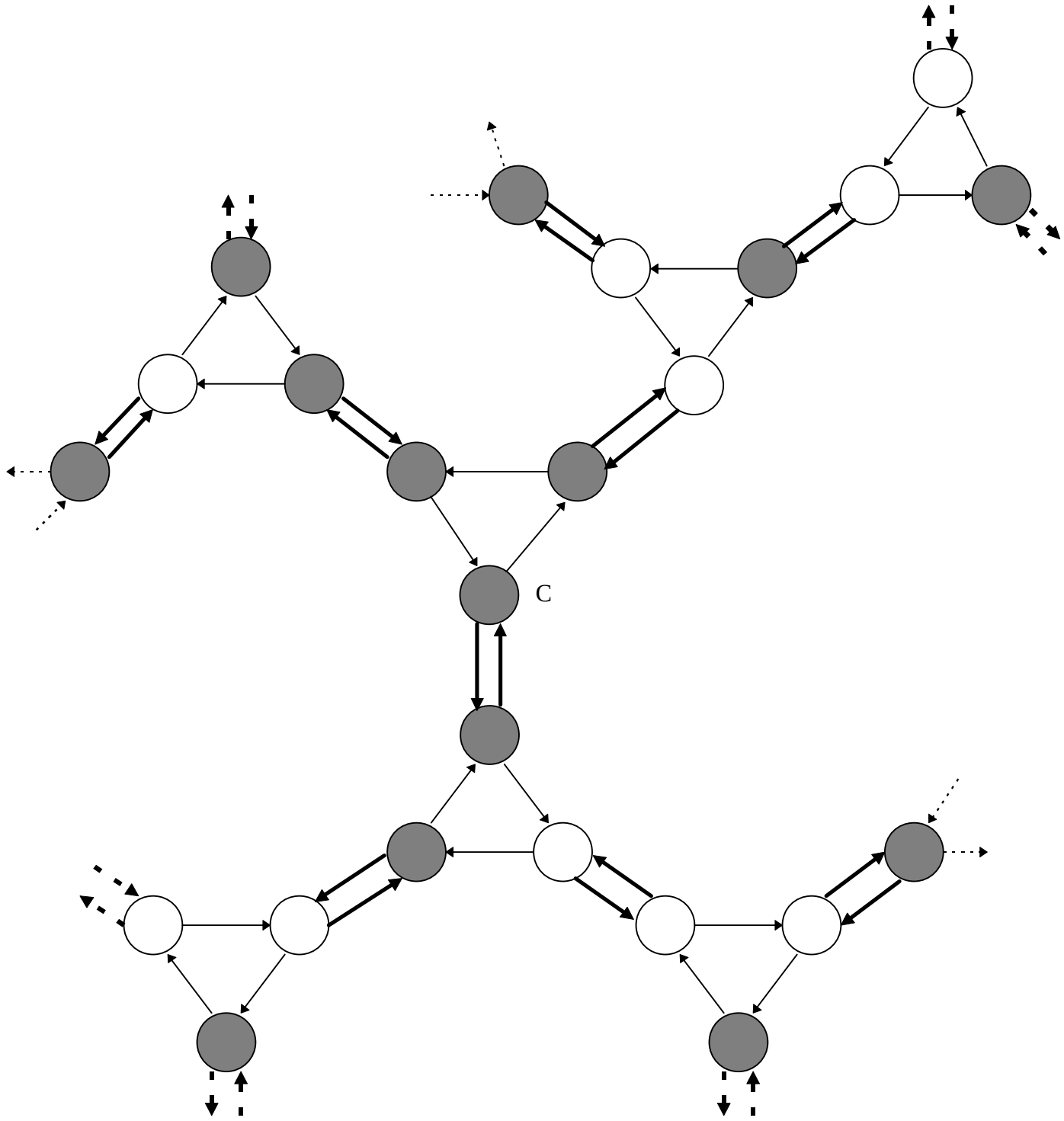
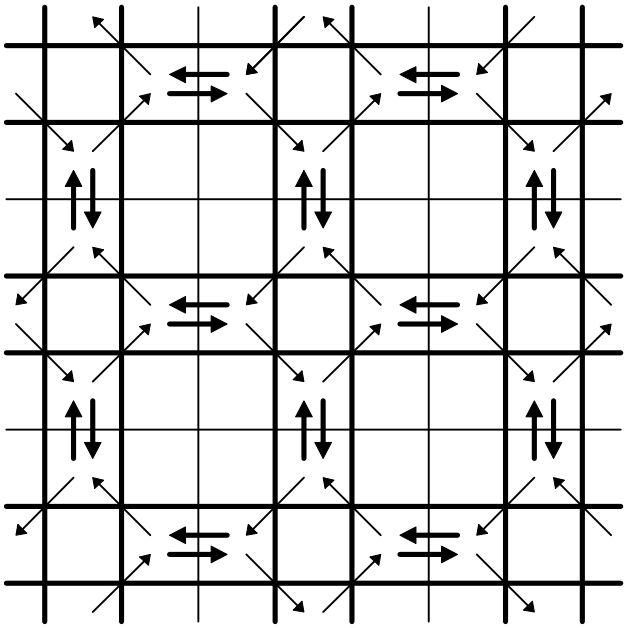


Fig. 6. CP-L-R (2, 3), generation 5.

(a)



(b)

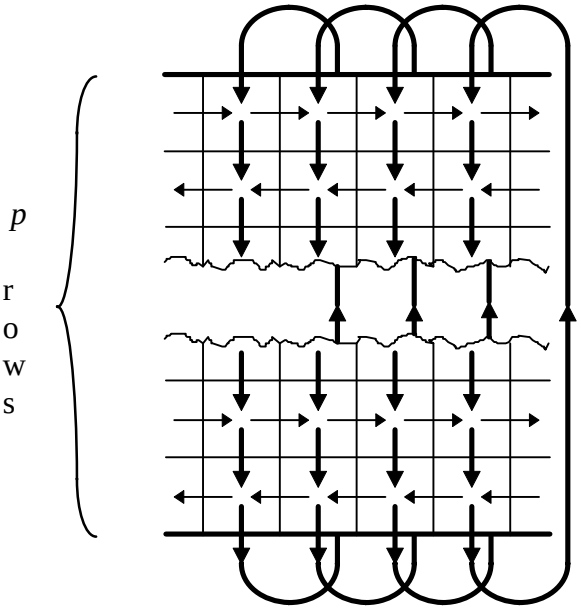


Fig. 7. Possible 2D representations of some CP-CAs on a tesselation:

(a) CP-MOSAIC automaton, presented as a tesselation with “holes”. Notice that not all squares on a lattice are used.

(b) Class of CP-CYLINDER (*p*) automata, presented as *p* lines of squares, where *p* is an even number.

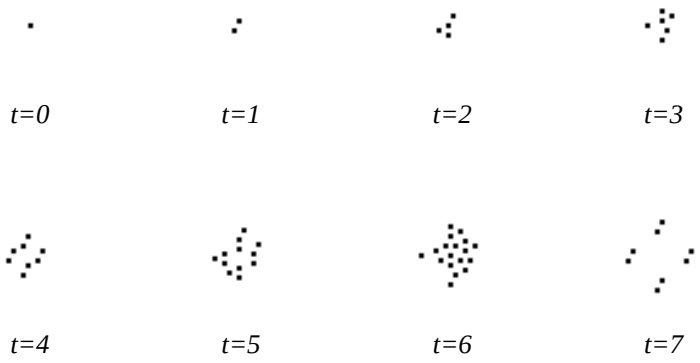
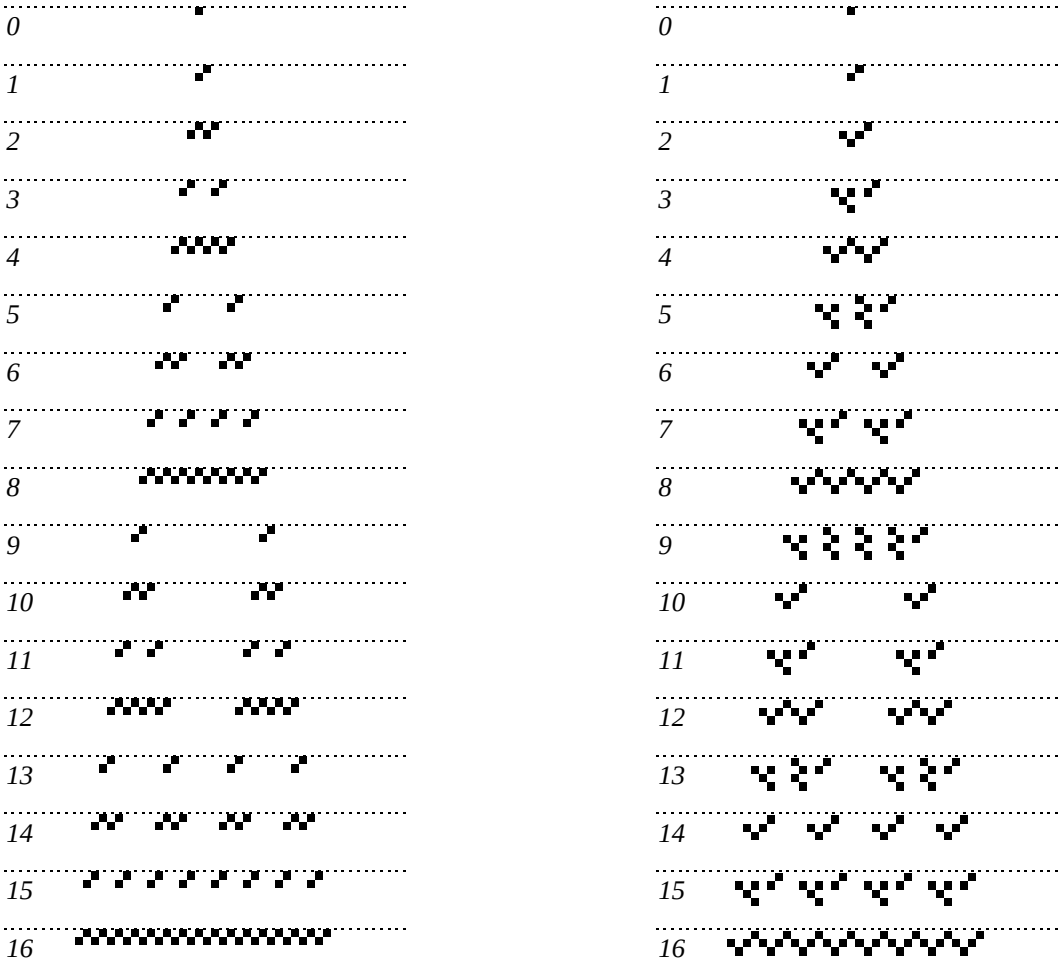


Fig. 8. CP-MOSAIC is still a replicator, regardless of his original topology. However, it has an unusual period of replication, as well as unusual replication pattern - couple of cells (cf. *t=1*, *t=4*, *t=7*).



(a) (b)

Fig. 9. First two instances of CP-CYLINDER automata are replicators, similar to the well-known Sierpinski's triangle:

(a) CP-CYLINDER(2)
(b) CP-CYLINDER(4)

Notice, however, that some generations of CP-CYLINDER(4) tend to be asymmetrical (case b, t=2,3,5,9).

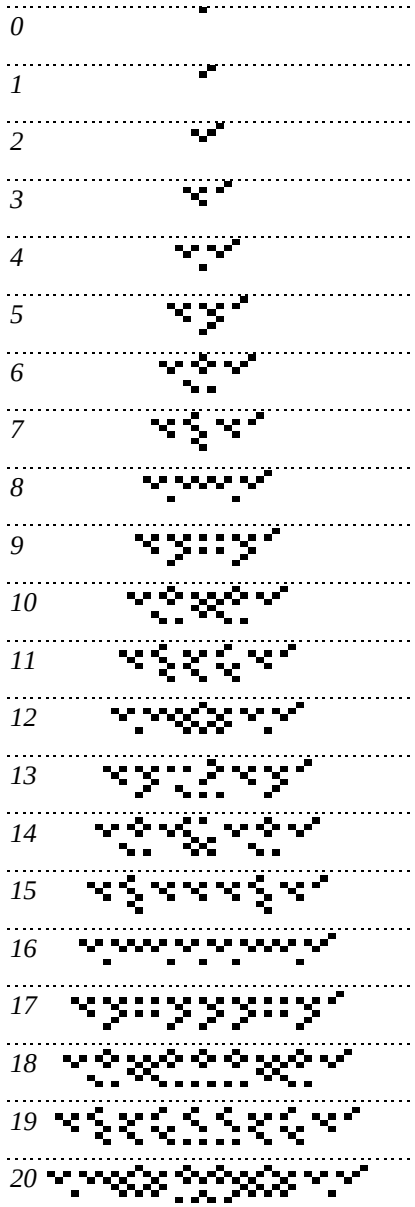


Fig. 10. Beyond belief: CP-CYLINDER(6) is *not* a replicator!

CP-CYLINDER(6) is the simplest example of the class of CP-CYLINDER automata, which has a non-replicative behavior. On the picture only first twenty generations are shown, but it is clear enough, that no replicator will be born. Most generations have a remarkable asymmetrical structure which, nevertheless, preserves somehow the general symmetry between its left and right side.

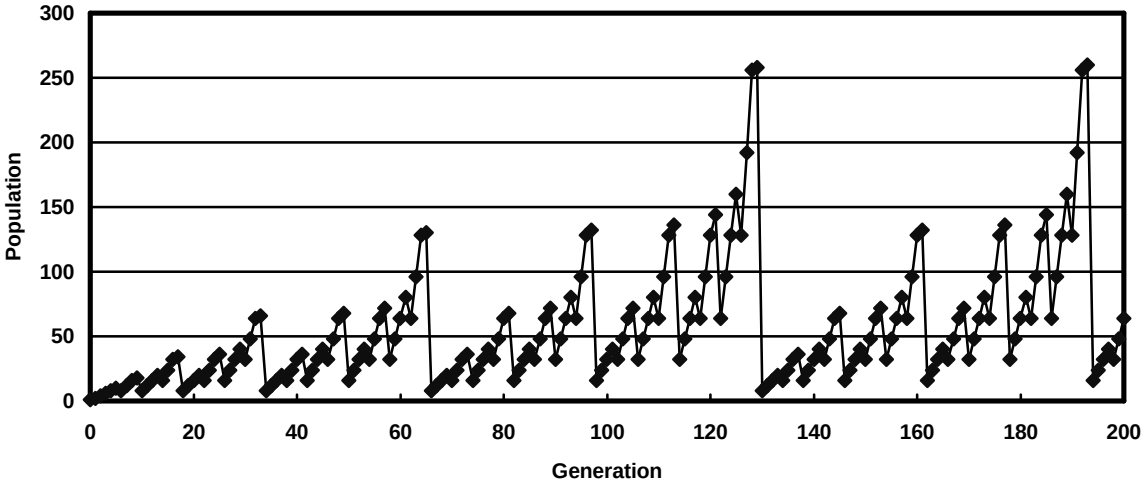


Fig. 11a. Typical population history of a replicative automaton (CP-CYLINDER (4) is shown).

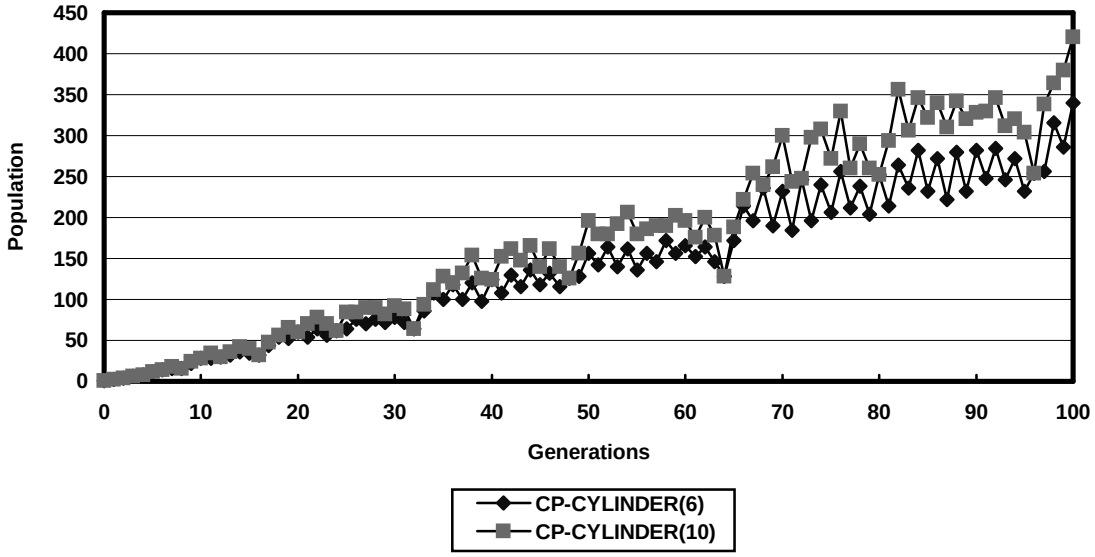


Fig. 11b. Populations of first two non-replicative CP-CYLINDERs.

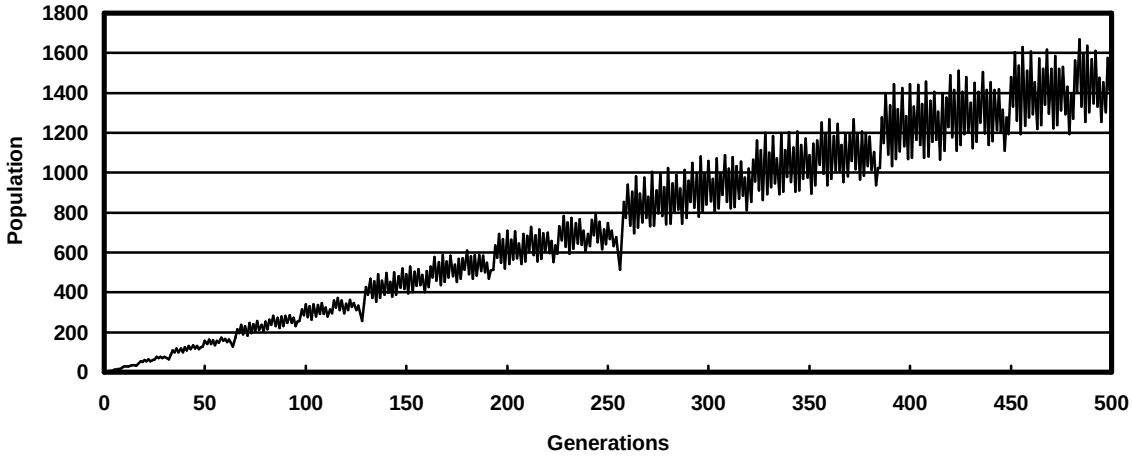


Fig. 11c. First 500 generations/populations of CP-CYLINDER (6).

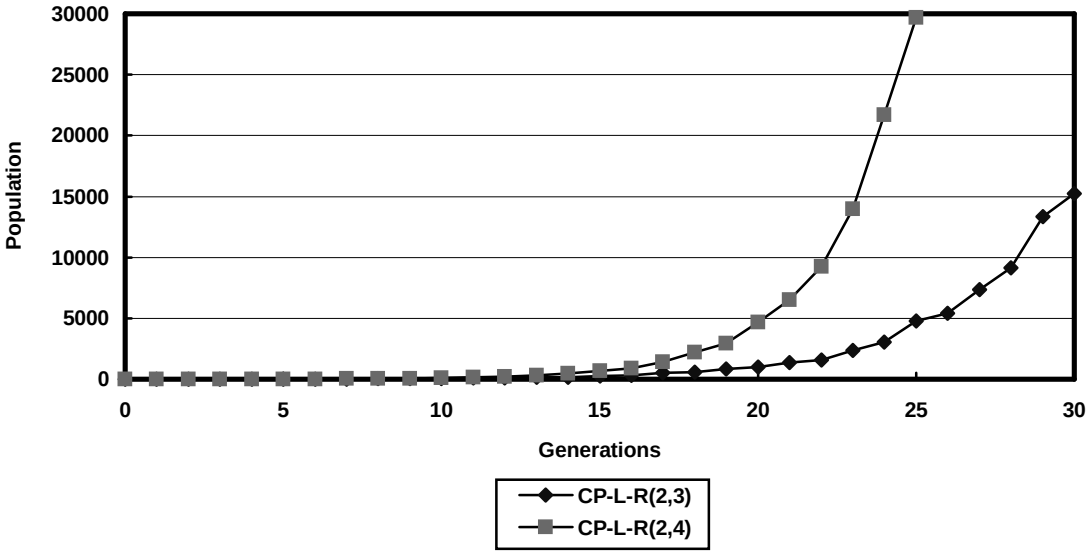


Fig. 11d. Populations of first two non-replicative CP-LRs.

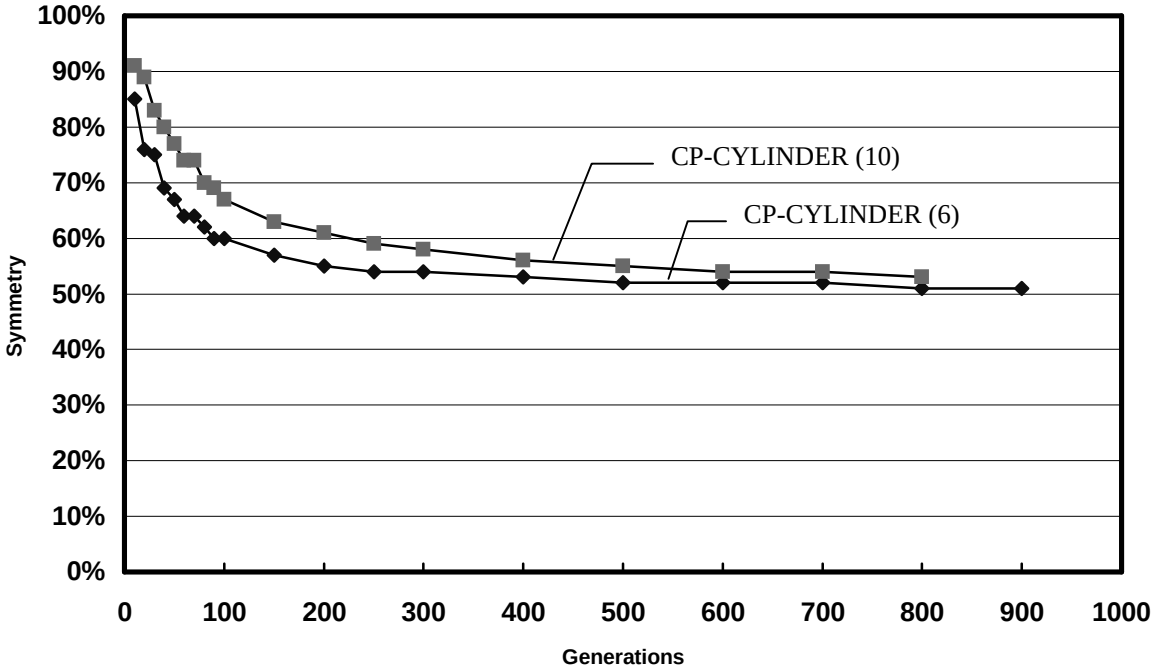


Fig. 12. Dynamic symmetry of first two non-replicative CP-CYLINDERs drops down to 50%.

Fig. 13. Symmetry map of CP-CYLINDER (6) for *t=50*.

All symmetrical cells are shown in black, non-symmetrical – in gray, and unused cells are left blank.

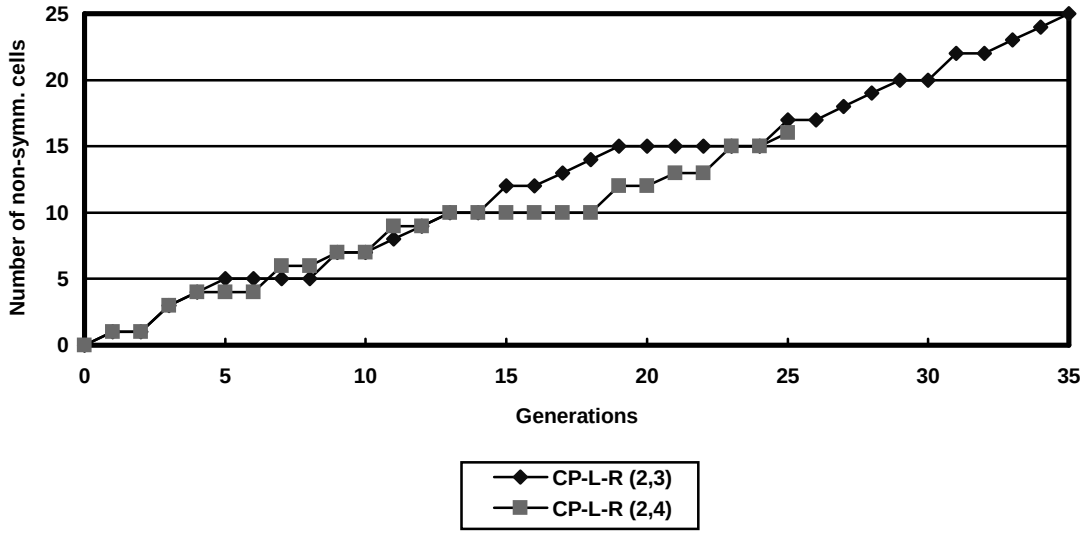


Fig. 14. Increasing number of non-symmetrical cells of CP-L-Rs gives us an awareness to classify these automata as non-replicative.

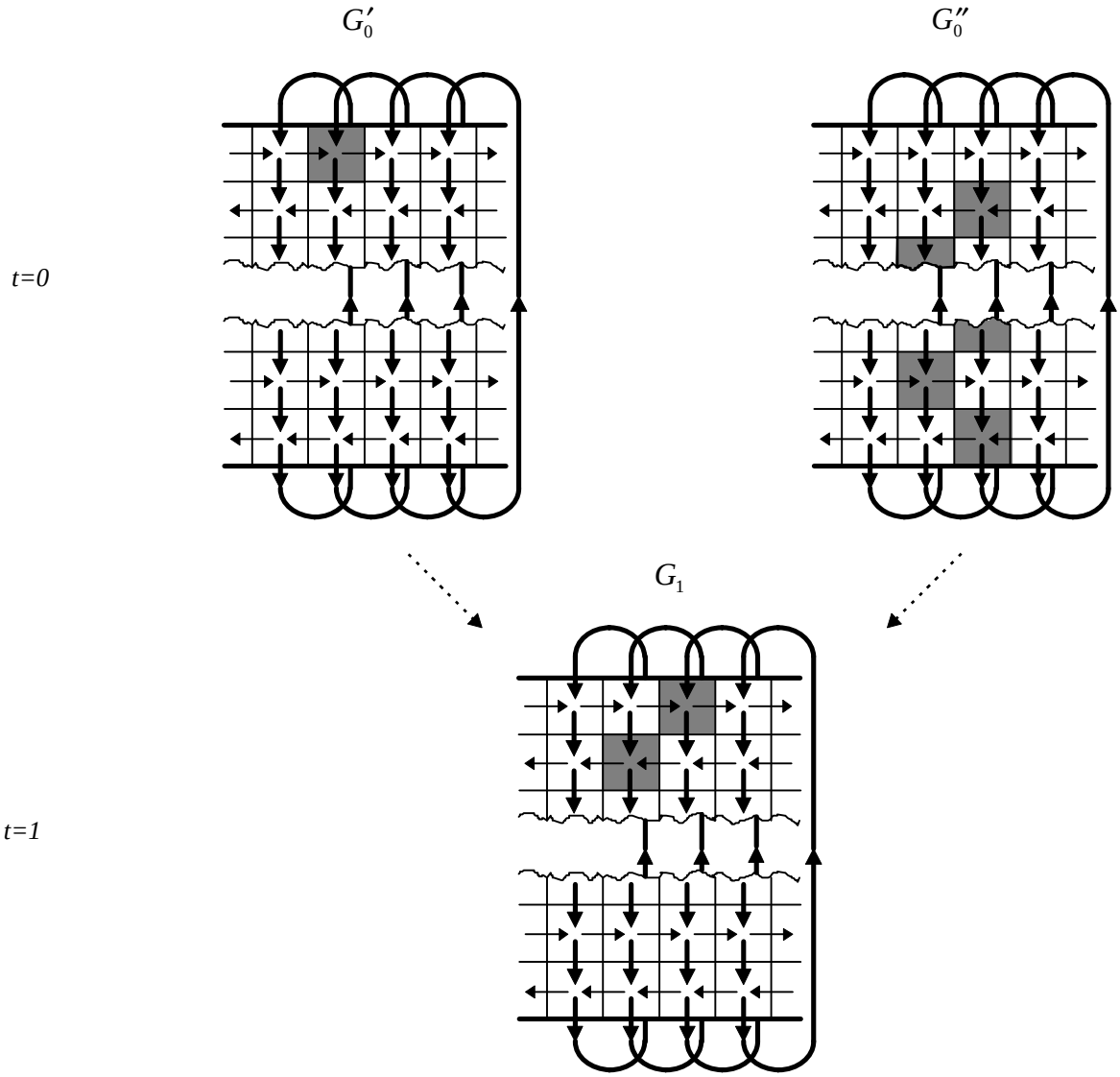


Fig. 15. CP-CYLINDERs are not reversible: both configurations on the top (*t=0*) lead to one and the same configuration at the bottom (*t=1*).

(a)

(b)

(c)

(d)

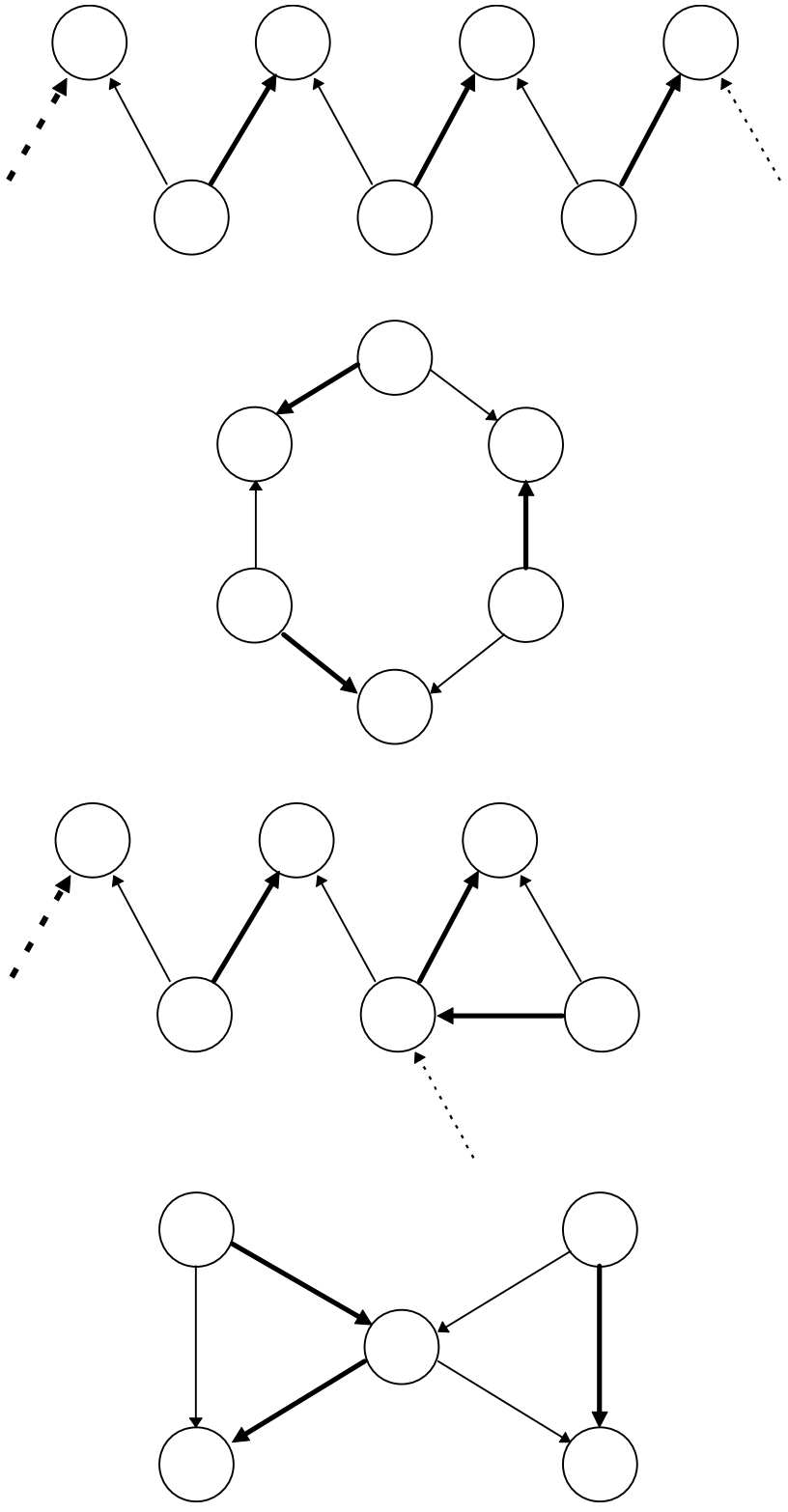


Fig. 16. Four examples of different types of reversive chains:
a) Non-crossed non-cyclic
b) Non-crossed cyclic
c) Self-crossed non-cyclic
d) Self-crossed cyclic

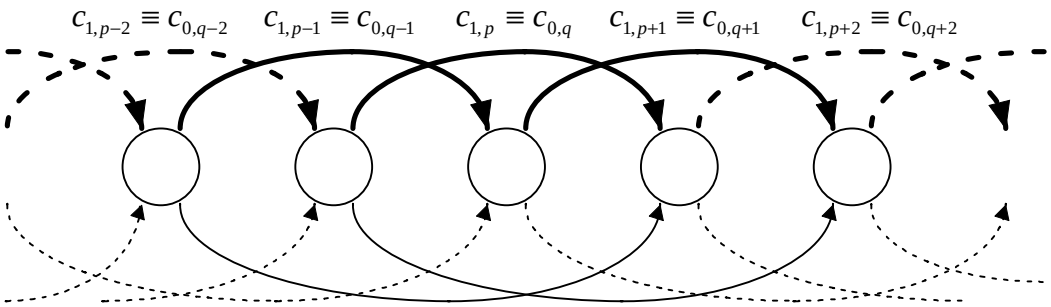


Fig. 17. Non-cyclic self-crossed chain, which satisfies eq. (14) of the Lemma. However, this is not an example of CP-CA (information here "flows" only rightwards, i.e. Condition 5 of the definition of CP-CAs is violated).