Lukas Gesing, Patrick Kaster
MA-INF 4201 - Artificial Life
Exercise Sheet 2

Assignment 9

$Z = k^{k^{(2 \cdot r+1)}} = 4^{4^{2+1}} = 4^{4^3} = 3,402823669 \cdot 10^{38}$ possible rules. Printing 100 rules per second this would take $3,402823669 \cdot 10^{38}$ seconds, or $1,079028307 \cdot 10^{29}$ years.

■

Assignment 10

Disprove by contradicting example: The depicted rule is totalistic. But it is illegal,

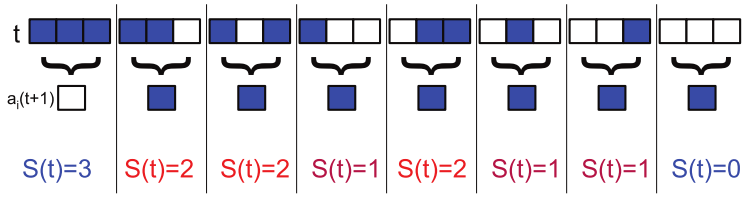

Figure 1: totalistic but illegal rule

since it lacks a silent state, though it is symmetric.

■

Assignment 11

■

Assignment 12

$150_D = 10010110_B$

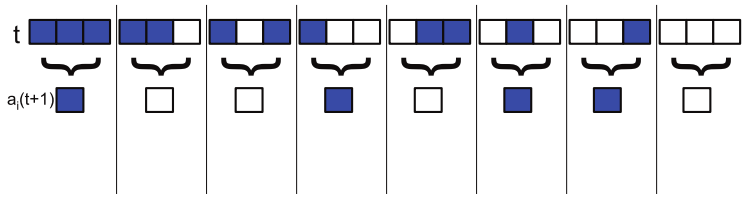

Figure 2: rule 150_D

It follows: $S(t) = 3 \Rightarrow 1, S(t) = 2 \Rightarrow 0, S(t) = 1 \Rightarrow 1, S(t) = 0 \Rightarrow 0$. Thus, the rule can be expressed by the formula: $\mod (\sum_i a_i, 2)$. The remainder of division by 2 of the sum of the neighbourhood.

A cellular automaton for the rule is depicted in table 1. The formula is implemented in the file `task12.ods`.

■

0	0	1	0	0	0	1	0	1	0	0	0
0	1	1	1	0	1	1	0	1	1	0	0
0	0	1	0	0	0	0	0	0	0	1	0
0	1	1	1	0	0	0	0	0	1	1	0
0	0	1	0	1	0	0	0	1	0	0	0
0	1	1	0	1	1	0	1	1	1	0	0
0	0	0	0	0	0	0	0	1	0	1	0
0	0	0	0	0	0	0	1	1	0	1	0
0	0	0	0	0	0	1	0	0	0	1	0
0	0	0	0	0	1	1	1	0	1	1	0
0	0	0	0	1	0	1	0	0	0	0	0
0	0	0	1	1	0	1	1	0	0	0	0
0	0	1	0	0	0	0	0	1	0	0	0
0	1	1	1	0	0	0	1	1	1	0	0
0	0	1	0	1	0	1	0	1	0	1	0
0	1	1	0	1	0	1	0	1	0	1	0
0	0	0	0	1	0	1	0	1	0	1	0
0	0	0	1	1	0	1	0	1	0	1	0
0	0	1	0	0	0	1	0	1	0	1	0
0	1	1	1	0	1	1	0	1	0	1	0

Table 1: 20 steps of rule 150_D, first row input is random input. Column 1 and 12 are fixed to 0.

Assignment 13

a) $Z = k^{k^{(2 \cdot r+1)}}$

b) $Z_p = \frac{1}{2} \cdot k^{k^{(2 \cdot r+1)}}$

c) $Z_t = k^{2^{(2 \cdot r+1)}-1}$, since in a $2 \cdot r + 1$ neighbourhood, their can be $2^{(2 \cdot r+1)} - 1$ different sums (each cell having k possible values).

d) $Z_{pt} = \frac{1}{2} \cdot Z_t$

■

Assignment 14

	2^7	2^6	2^5	2^4	2^3	2^2	2^1	2^0	
	■■■	■■□	■□■	■□□	□■■	□■□	□□■	□□□	
0_D	0	0	0	0	0	0	0	0	l,t,p
17_D	0	0	0	1	0	0	0	1	-
42_D	0	0	1	0	1	0	1	0	-
51_D	0	0	1	1	0	1	0	0	-
110_D	0	1	1	0	1	1	1	0	-
165_D	1	0	1	0	0	1	0	1	s,p
204_D	1	1	0	0	1	1	0	0	l
243_D	1	1	1	1	0	0	1	1	-

Table 2: Wolfram numbers and rules: l=legal, t=totalistic, s=symmetric, p=peripheral

■

Assignment 15

■