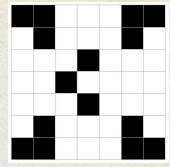
THE X-RULE



Universal Computation in a non-isotropic Like Life Cellular Automata

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Andrew Wuensche---Sussex University, Englang.

GAME OF LIFE

CELLULAR AUTOMATA

Let G be a group and let A be a set. A cellular automaton over the group G and the alphabet A is a map $\tau : A^G \to A^G$ satisfying the following property: there exist a finite subset $S \subset G$ and a map $\mu : A^S \to A$ such that

$$\tau(x)(g) = \mu((g^{-1}x)|_S) \tag{1}$$

for all $x \in A^G$ and $g \in G$, where $(g^{-1}x)|_S$ denotes the restriction of the configuration $g^{-1}x$ to S.

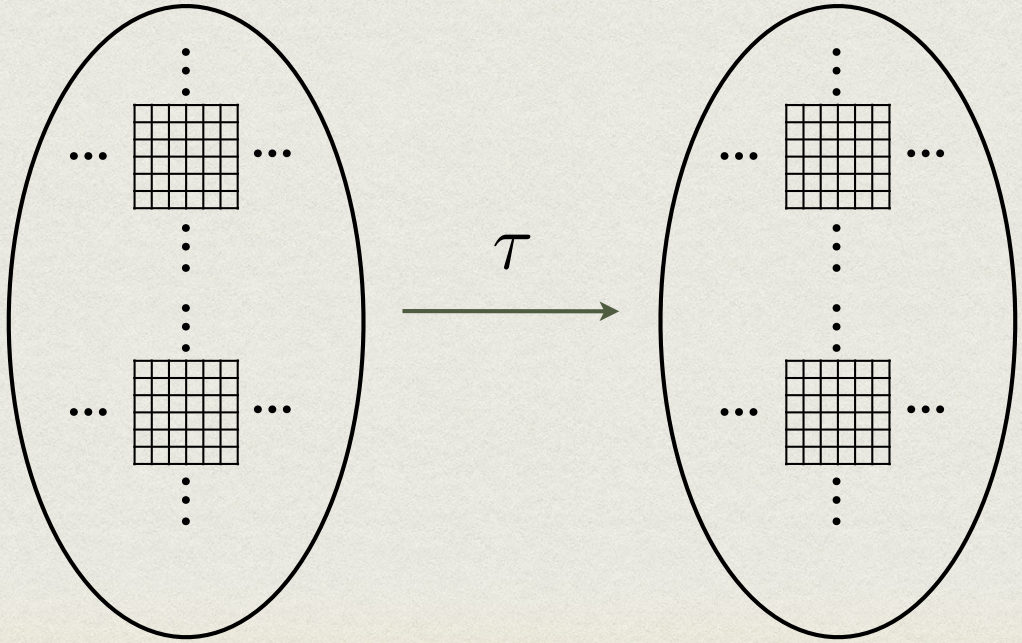
CELLULAR AUTOMATA

- El conjunto A es el *alfabeto.*
- Los elementos de A son los *estados.*
- El grupo G es el *Universo*
- Los elementos de A^G son las *configuraciones*
- El mapeo $\tau : A^G \to A^G$ es la *función global*
- S es la *vecindad*
- y μ es el mapeo local.

GAME OF LIFE

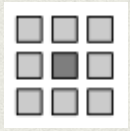
$$G = Z^2 \qquad A = \{0, 1\}$$

$$\tau : A^{Z^2} \to A^{Z^2}$$



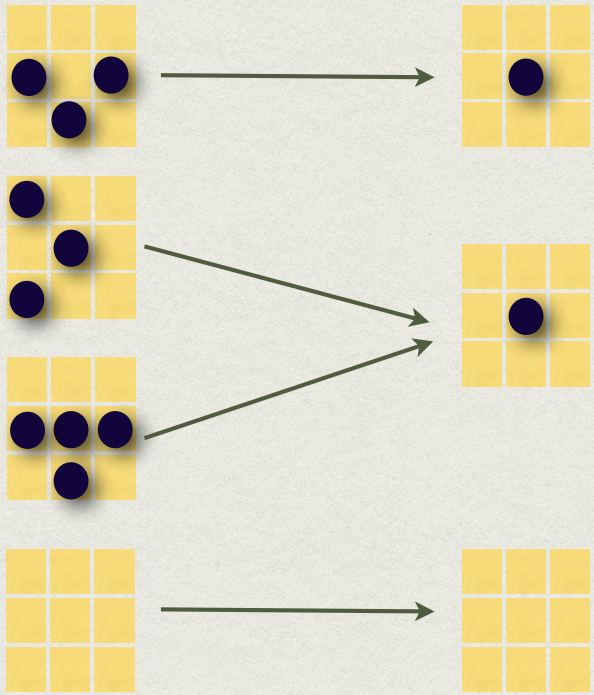
GAME OF LIFE

$$S = \{x_{-1,1}, x_{0,1}, x_{1,1}, x_{-1,0}, x_{0,0}, x_{1,0}, x_{-1,-1}, x_{0,-1}, x_{1,-1}\}$$



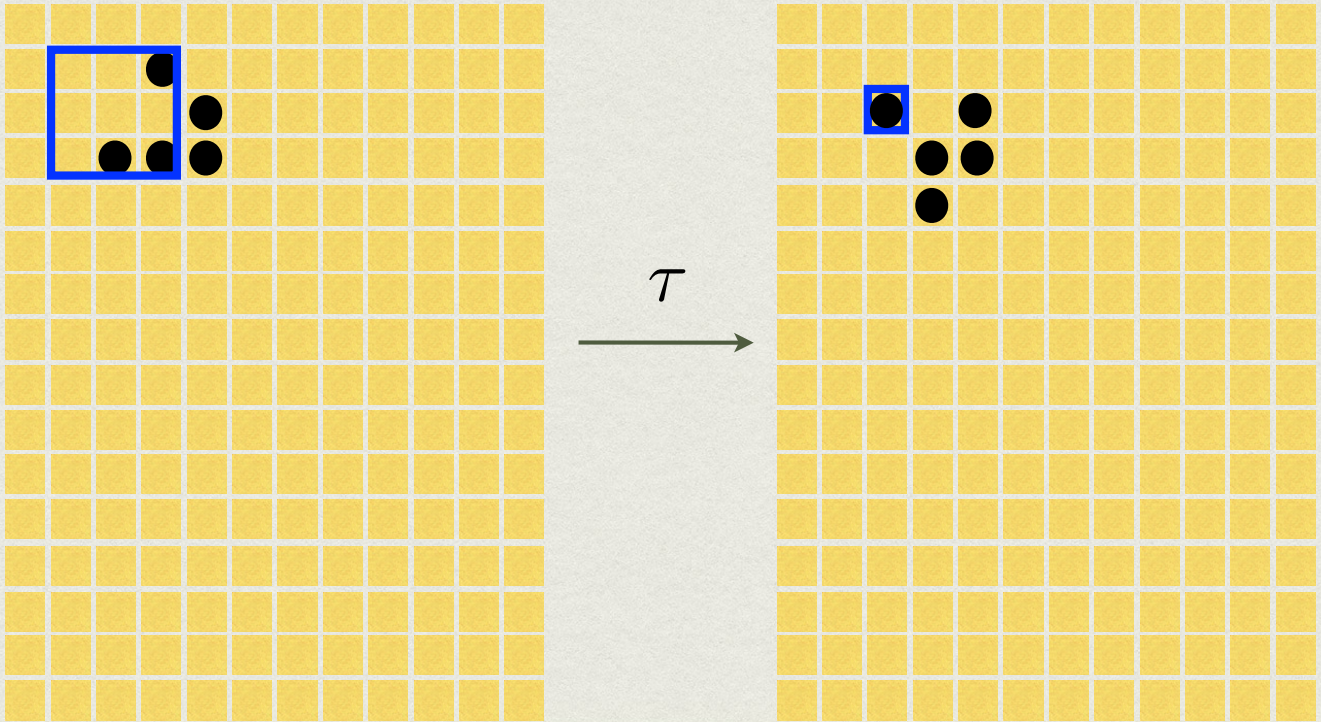
$$\begin{aligned} x_{i,j}^{t+1} = \mu(&x_{i-1,j-1}^{t}, x_{i-1,j}^{t}, x_{i-1,j+1}^{t}, \\ &x_{i,j-1}^{t}, x_{i,j}^{t}, x_{i,j+1}^{t}, \\ &x_{i-1,j-1}^{t}, x_{i-1,j}^{t}, x_{i-1,j+1}^{t}) \end{aligned}$$

$$\mu : A^S \to A$$



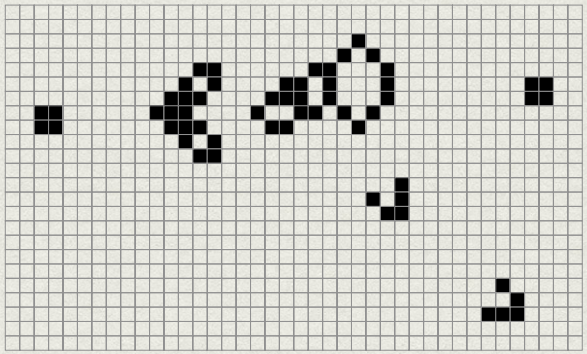
B3/S23

$$\tau(x)(g) = \mu((g^{-1}x)|_S)$$



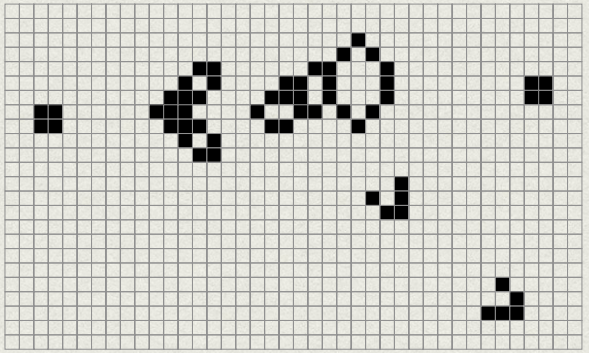
GAME OF LIFE

Glider Gun



GAME OF LIFE

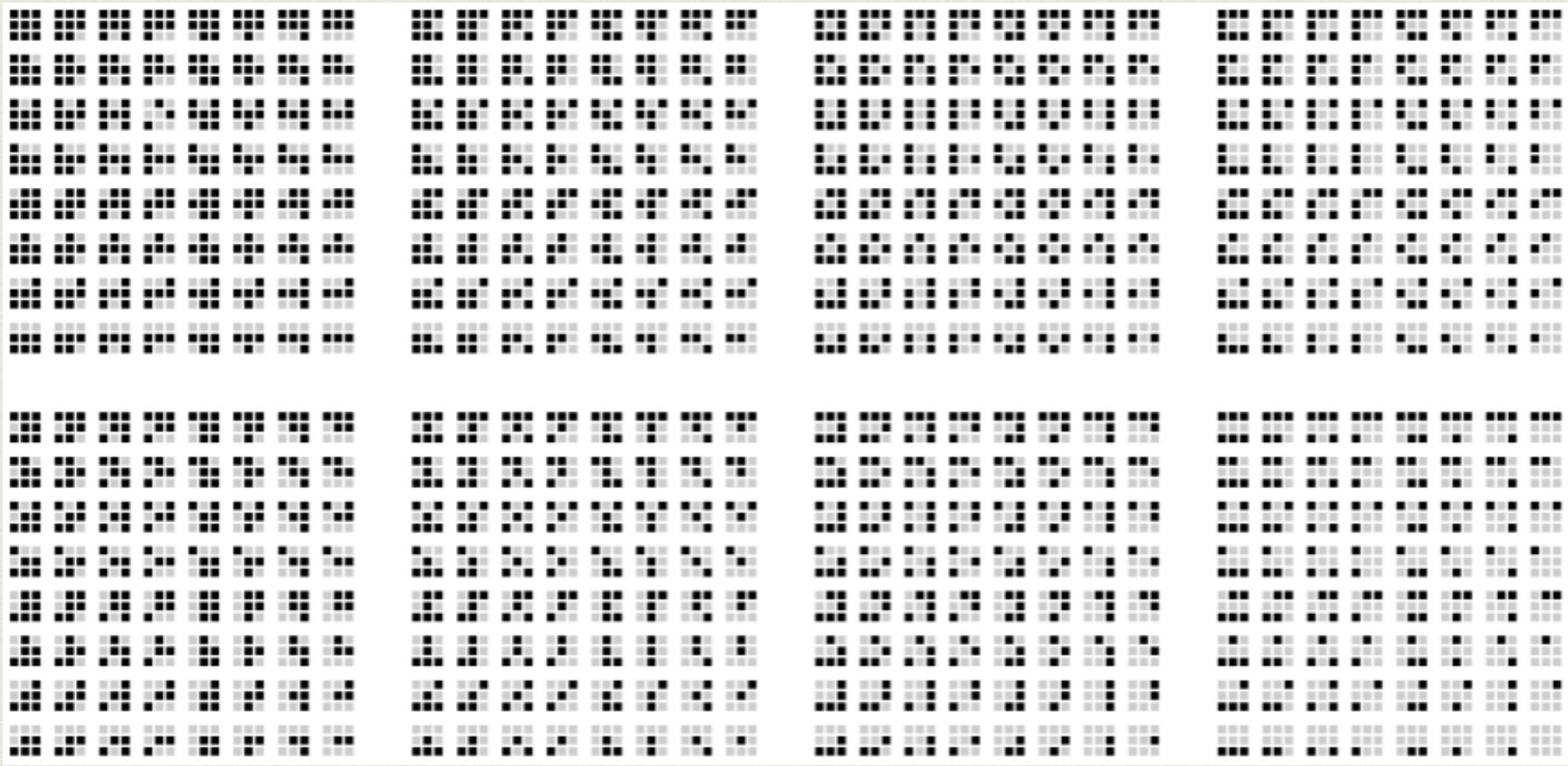
$G = Z^2 \qquad A = \{0, 1\}$



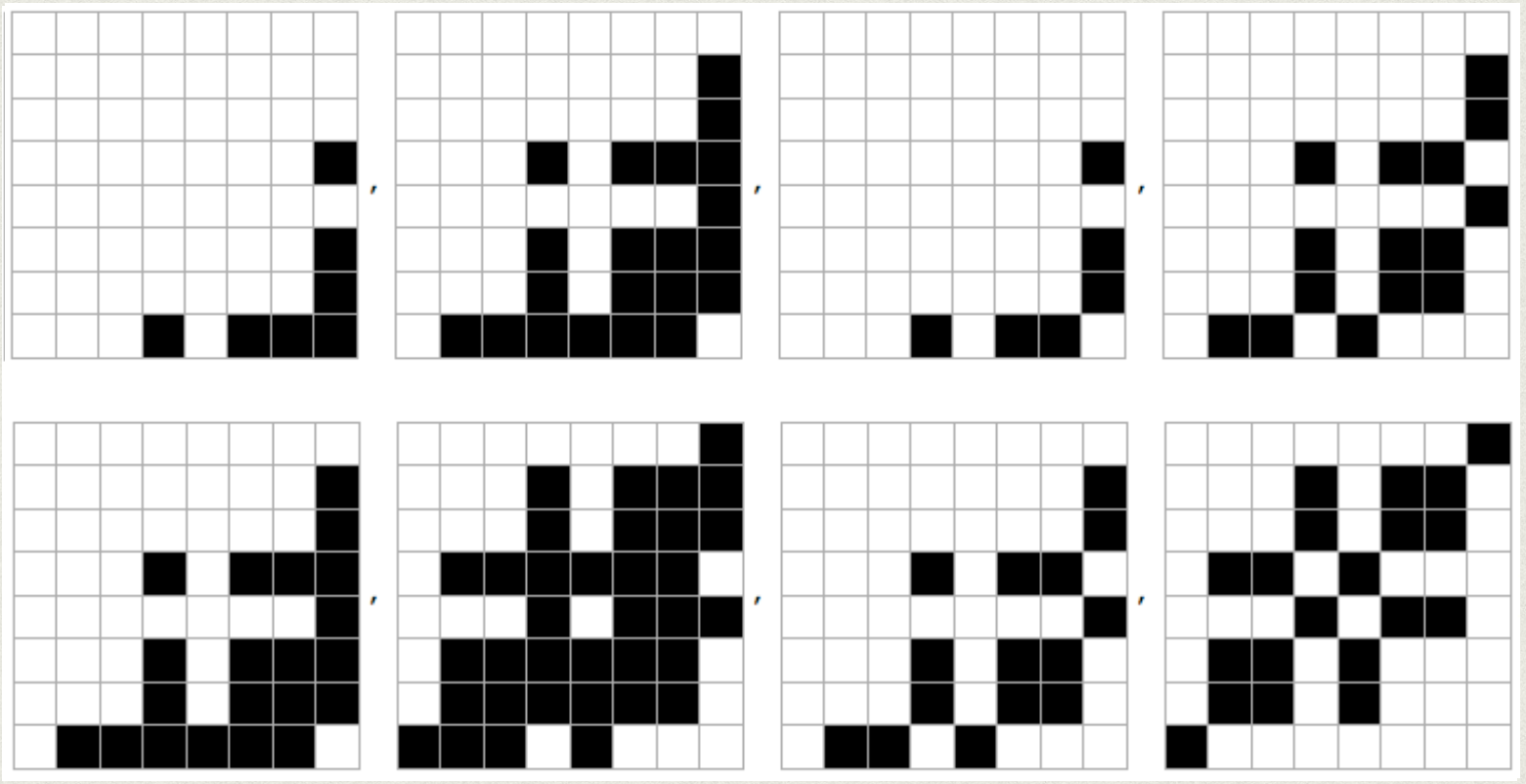
Glider Gun

$$S = \{x_{-1,1}, x_{0,1}, x_{1,1}, x_{-1,0}, x_{0,0}, x_{1,0}, x_{-1,-1}, x_{0,-1}, x_{1,-1}\}$$

A^S



$$\mu : A^S \to A$$



BORN/SURVIVE

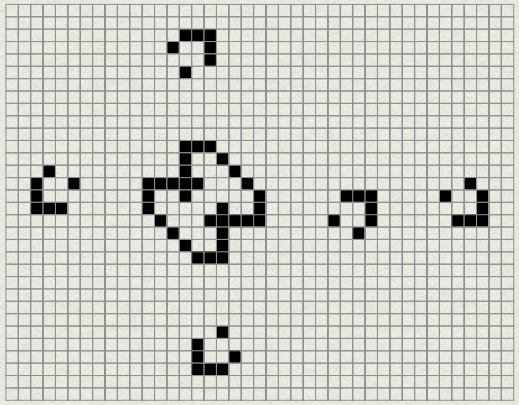
- B35678/S5678
- B35/S236
- B27/s0
- B2/S7
- B4678/S35678
- ....

BORN/SURVIVE

- B36/S23
- B368/S12578
- B3B3686/s245
- B368/S245
- B37/S23
- B3678/S34678

REGLA R

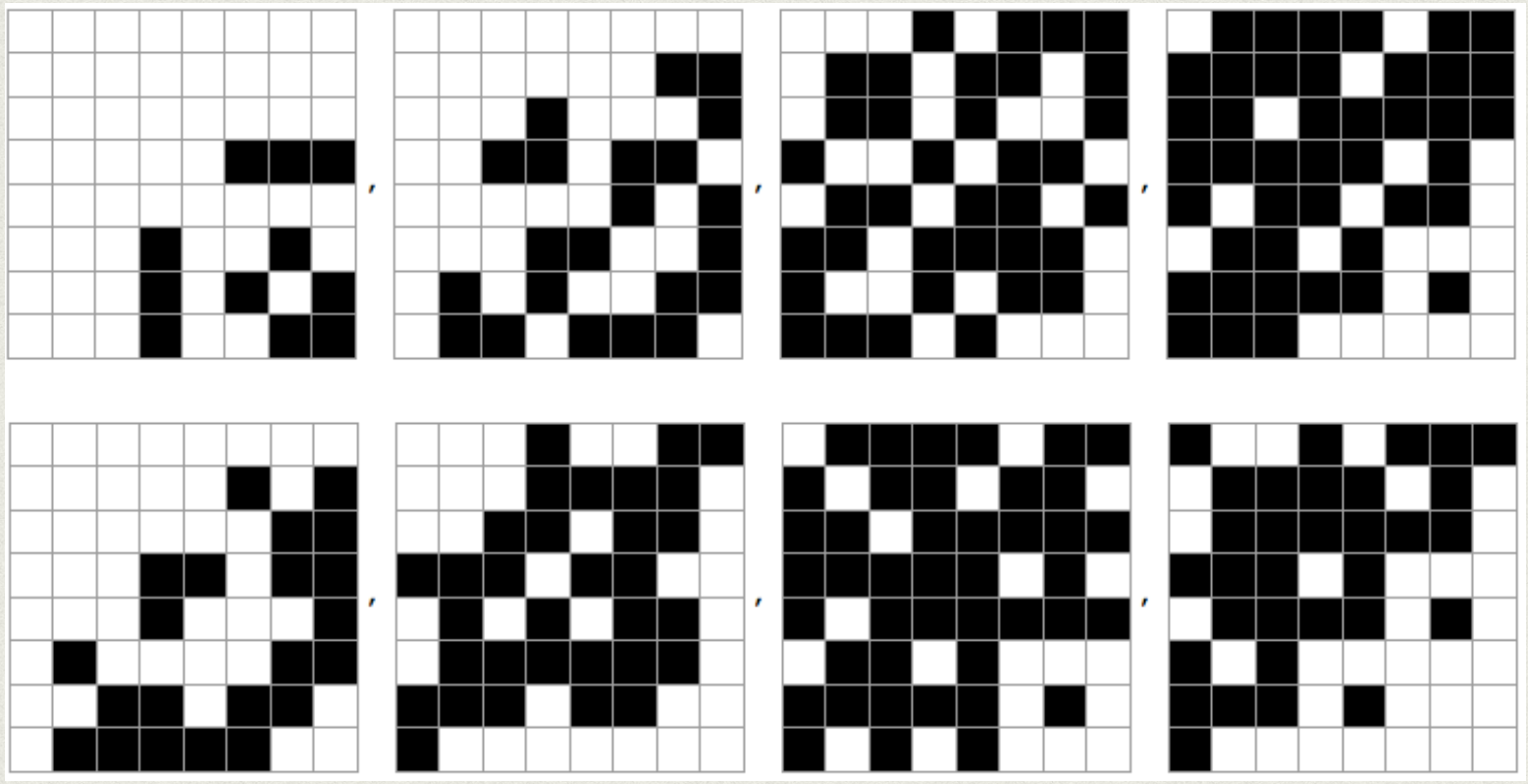
- Manuel Sapin (2004)



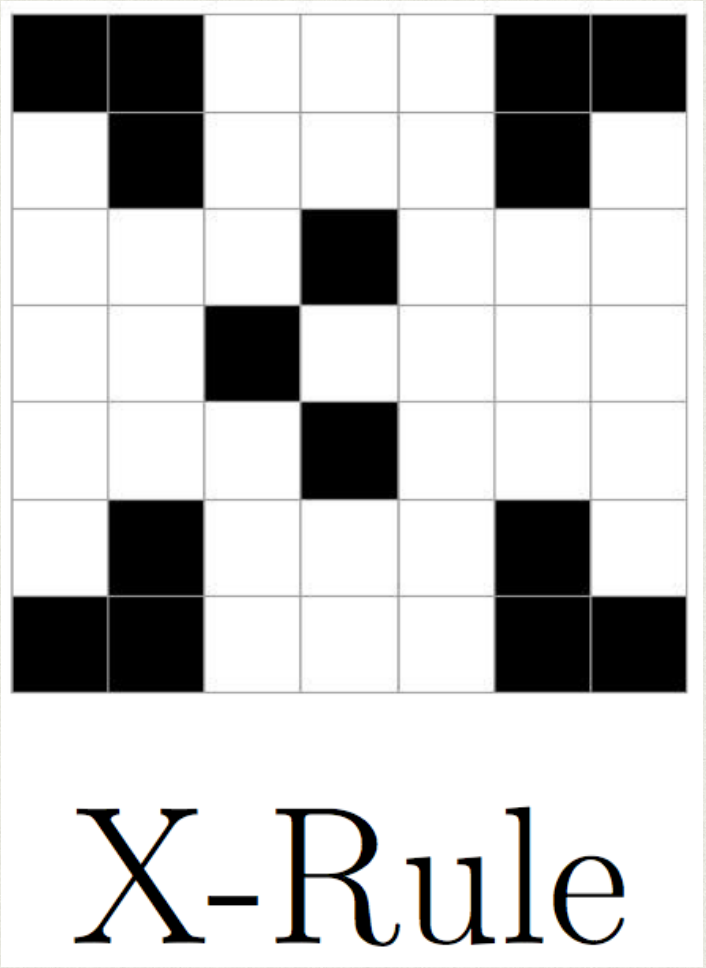
Glider Gun

REGLA R

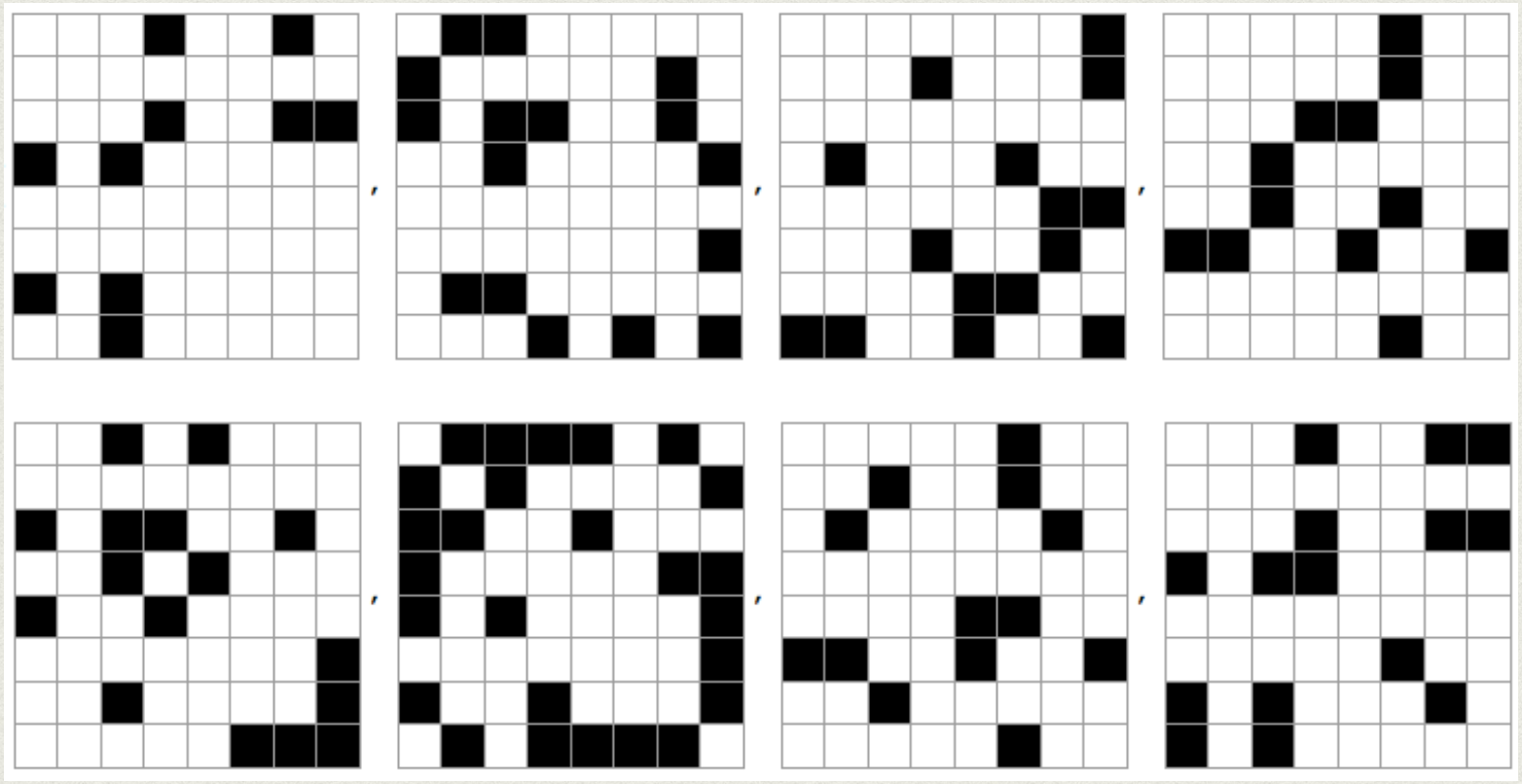
$$\mu : A^S \to A$$



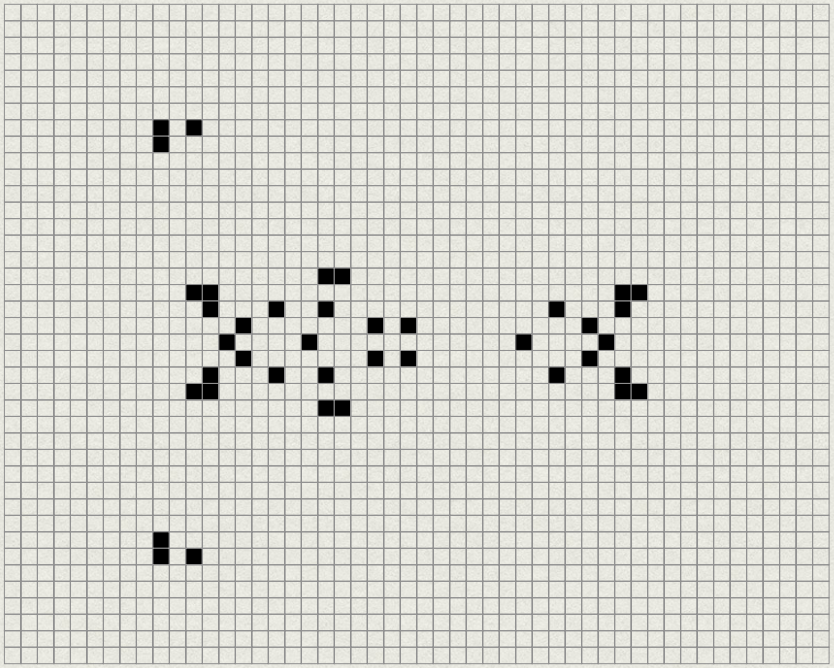
X-RULE



$$\mu : A^S \to A$$

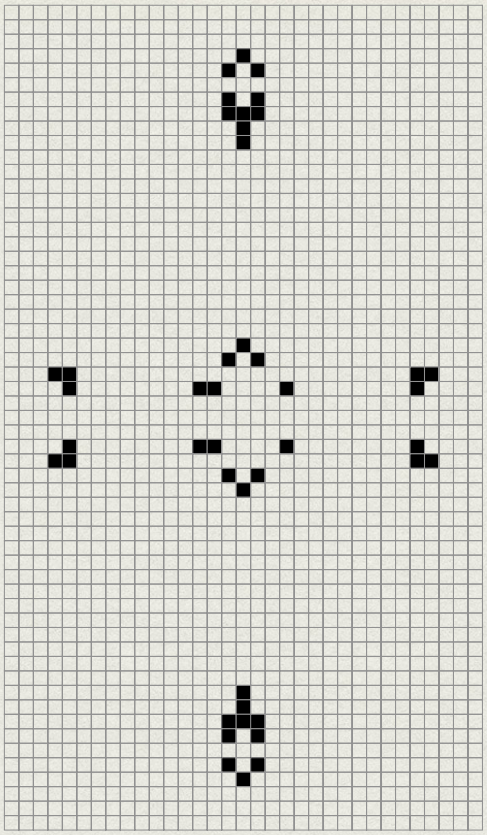


GLIDER GUN A



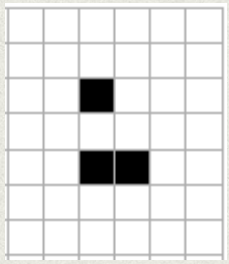
Glider Gun a

GLIDER GUN B

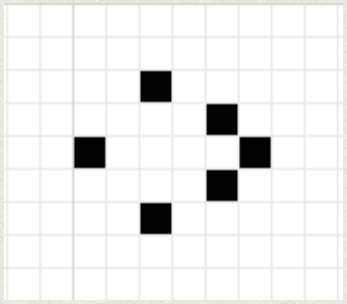


Glider Gun b

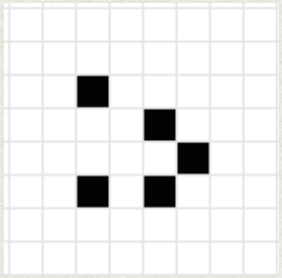
GLIDERS IN X-RULE



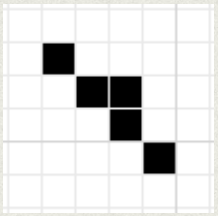
Glider a



Glider b

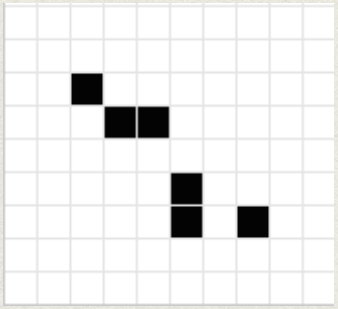


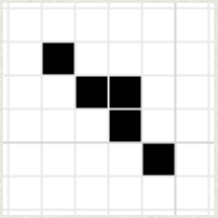
Glider c



composed a

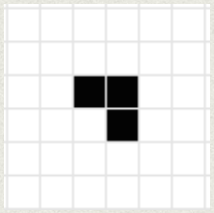
GLIDERS A COMPOSED



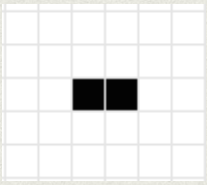


composed a

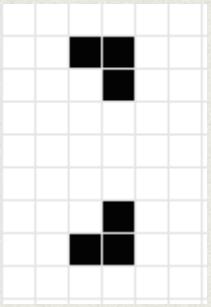
EATERS



eater a

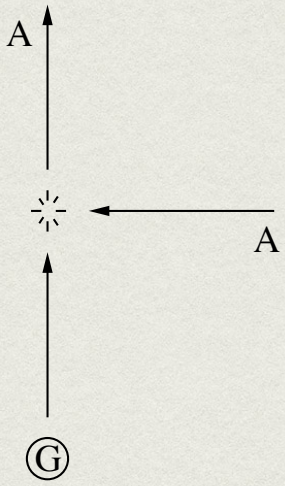


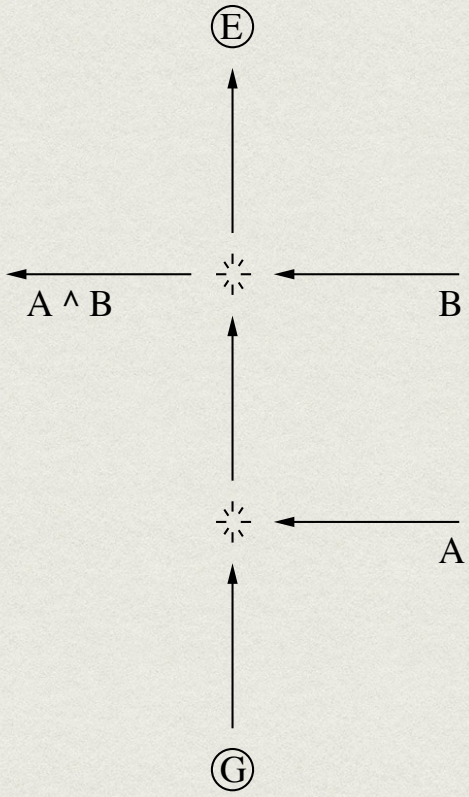
eater a-1

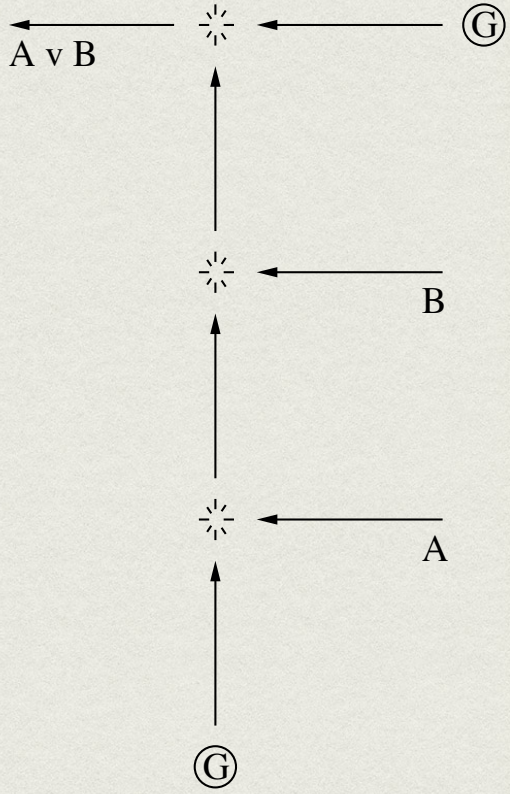


eater b

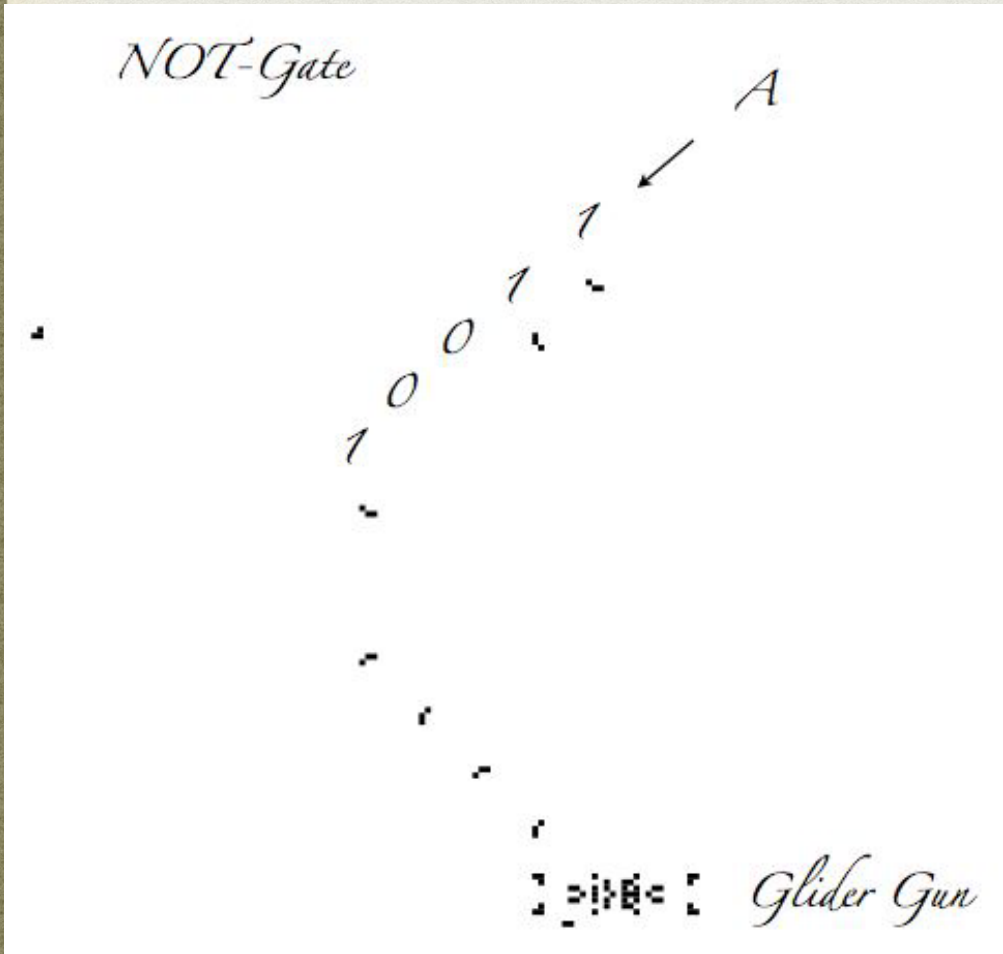
COMPUTATION IN X-RULE

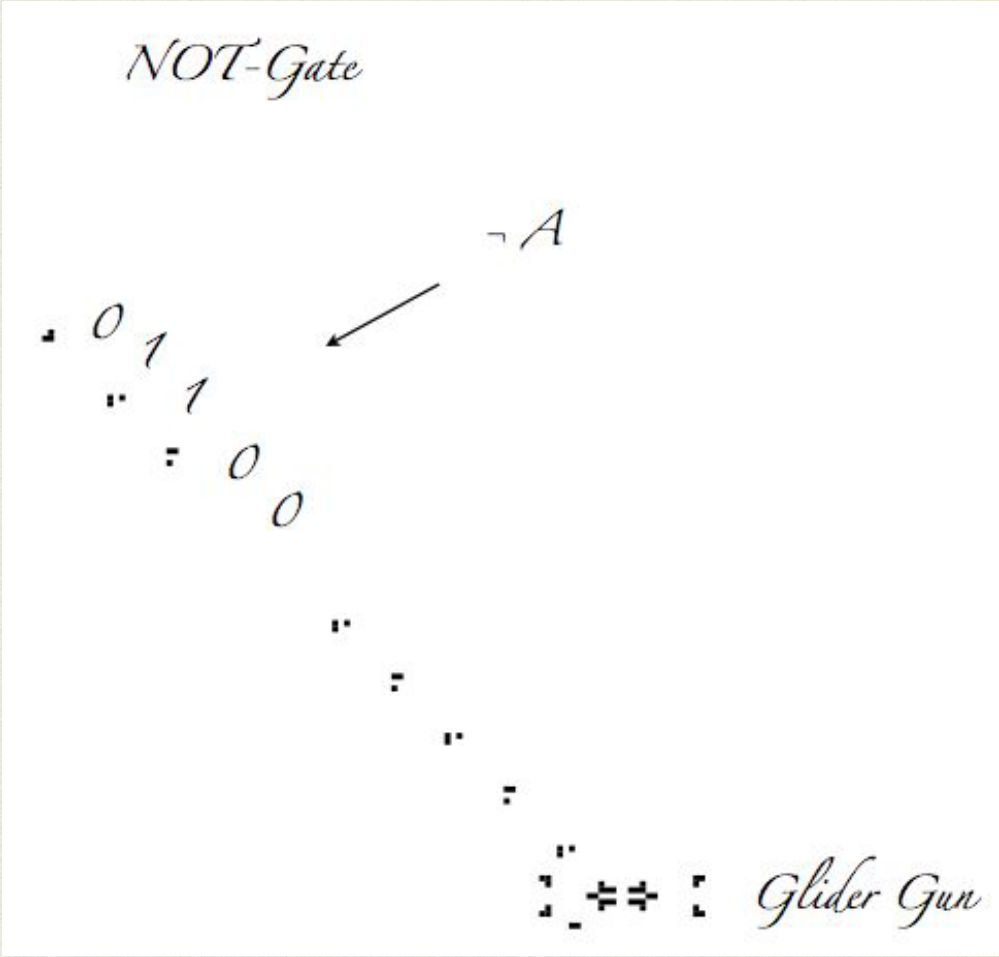




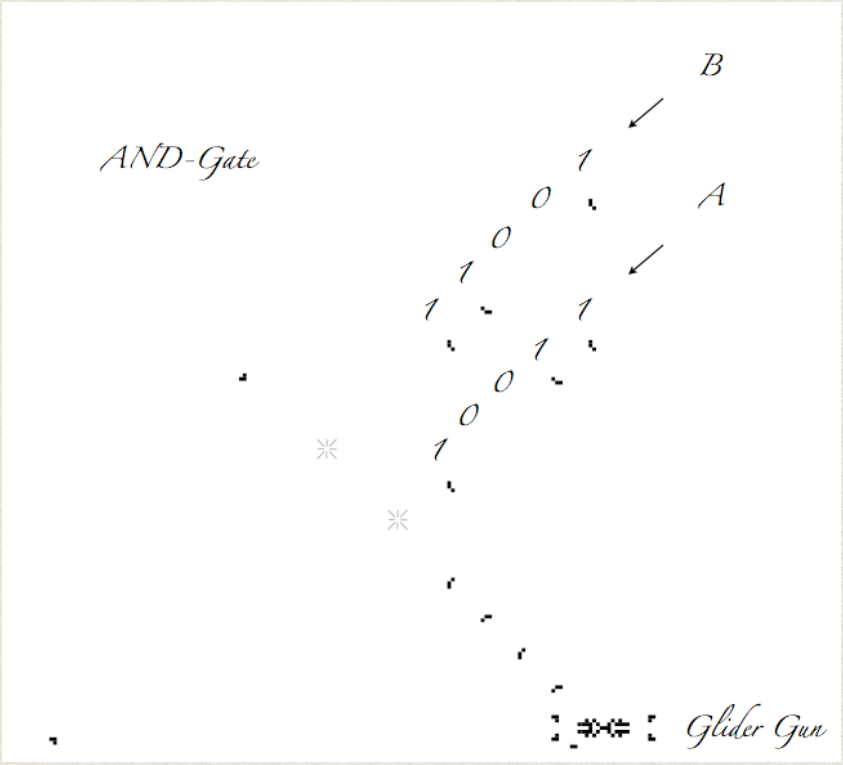


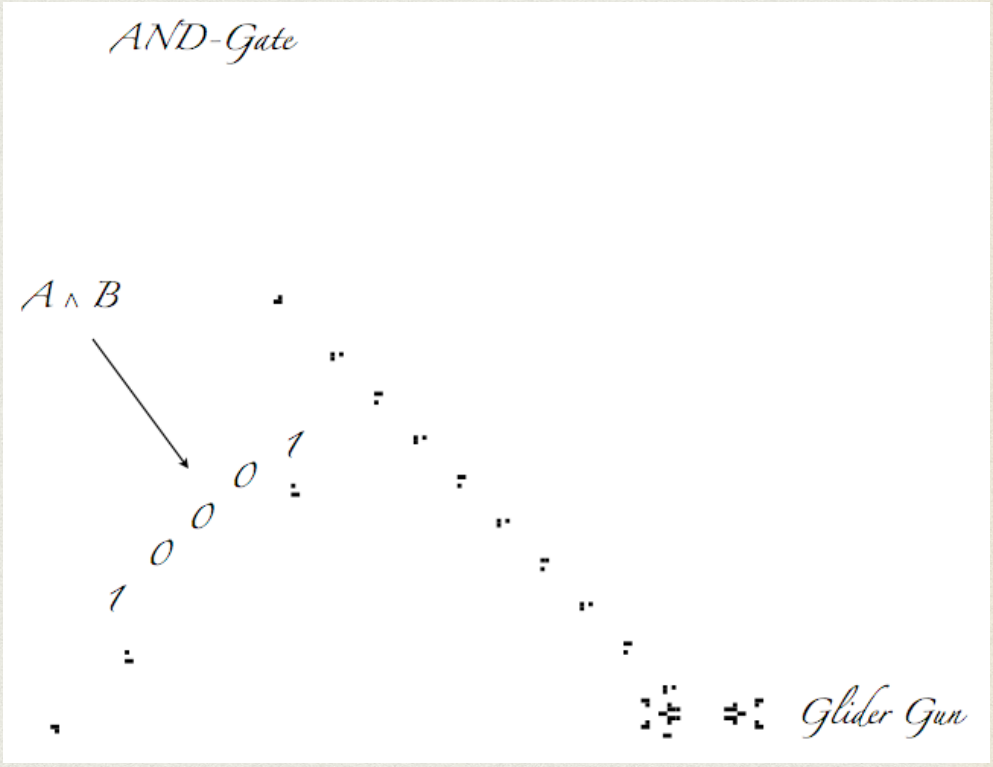
NOT GATE



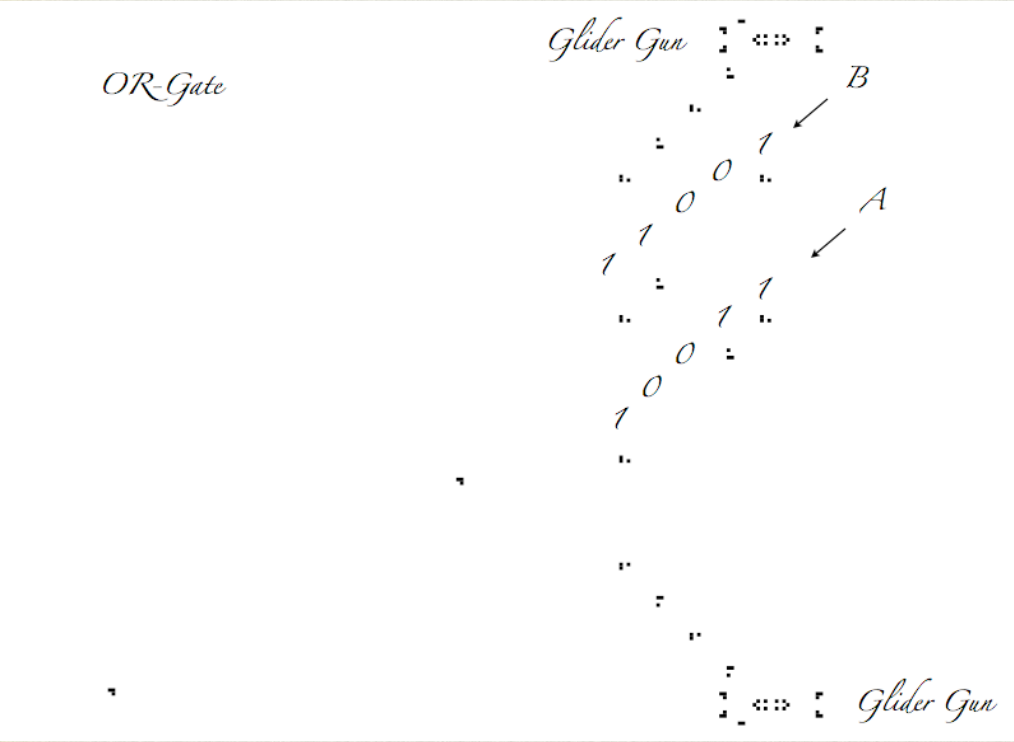


AND GATE



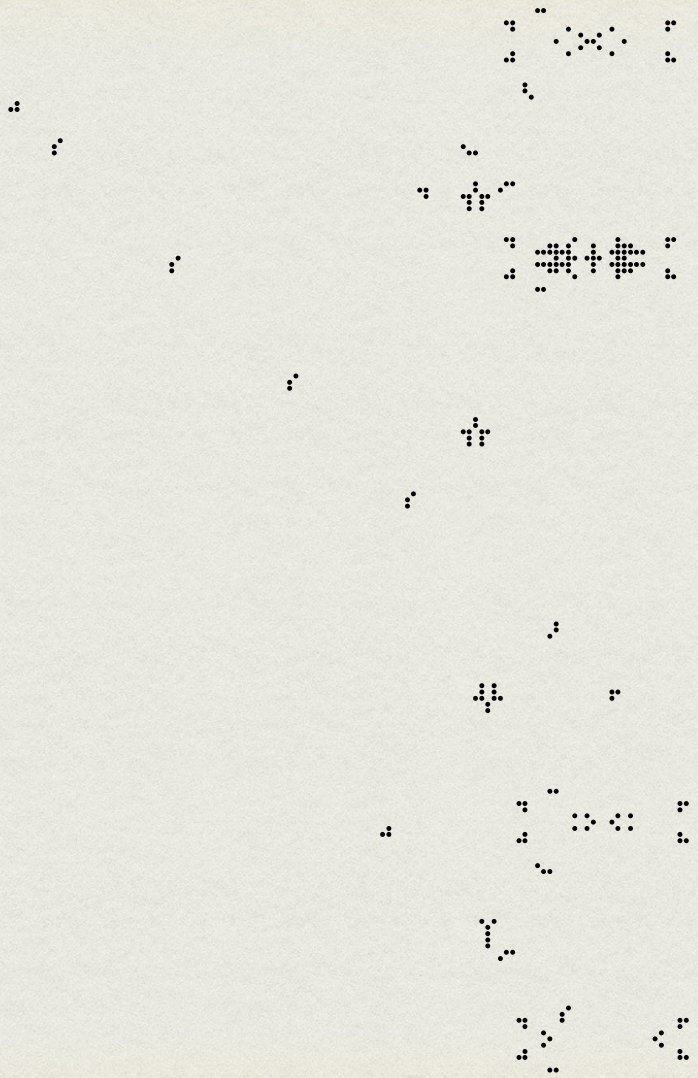


OR GATE


OR-Gate
Glider Gun
B
A
Glider Gun


OR-Gate
Glider Gun
A ∨ B
Glider Gun

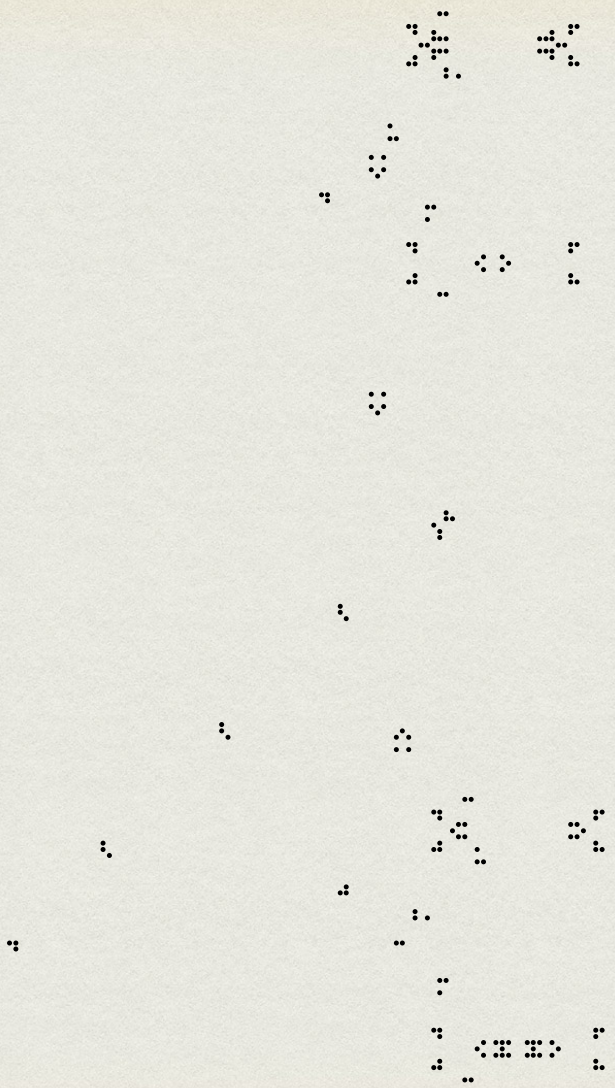
GLIDER GUN A COMPOSED



ggaNW
Composed

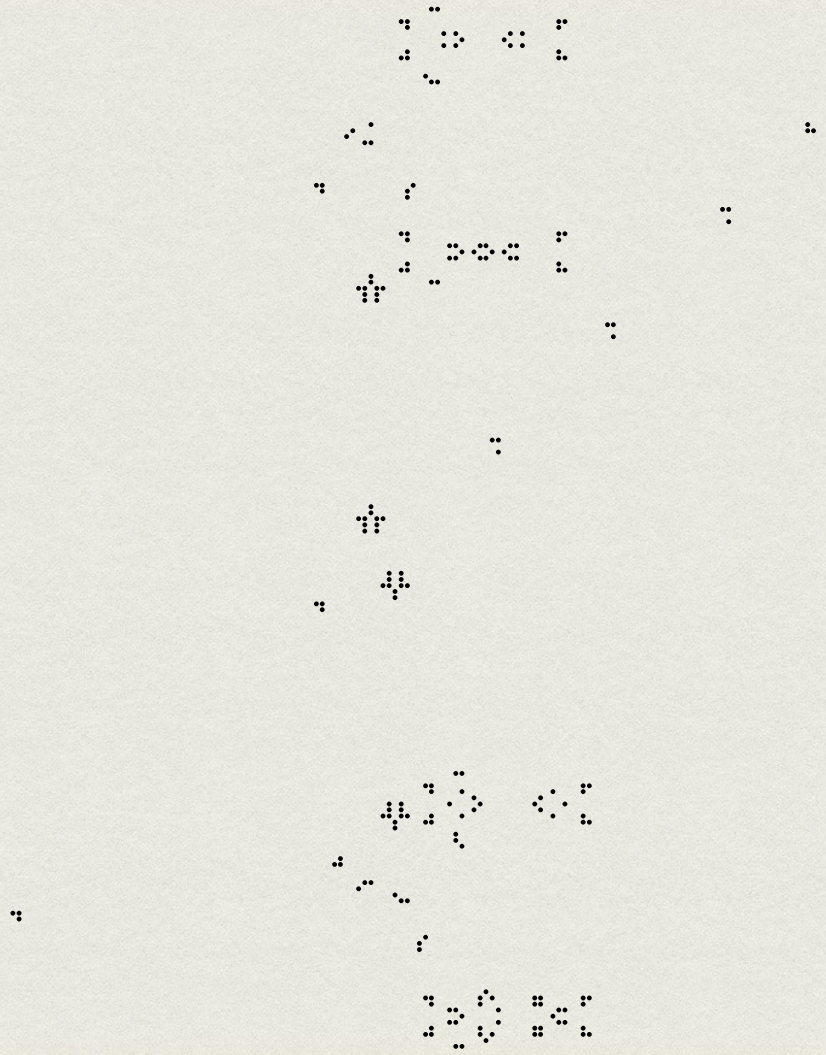
GLIDER GUN A COMPOSED

ggaSW
Composed



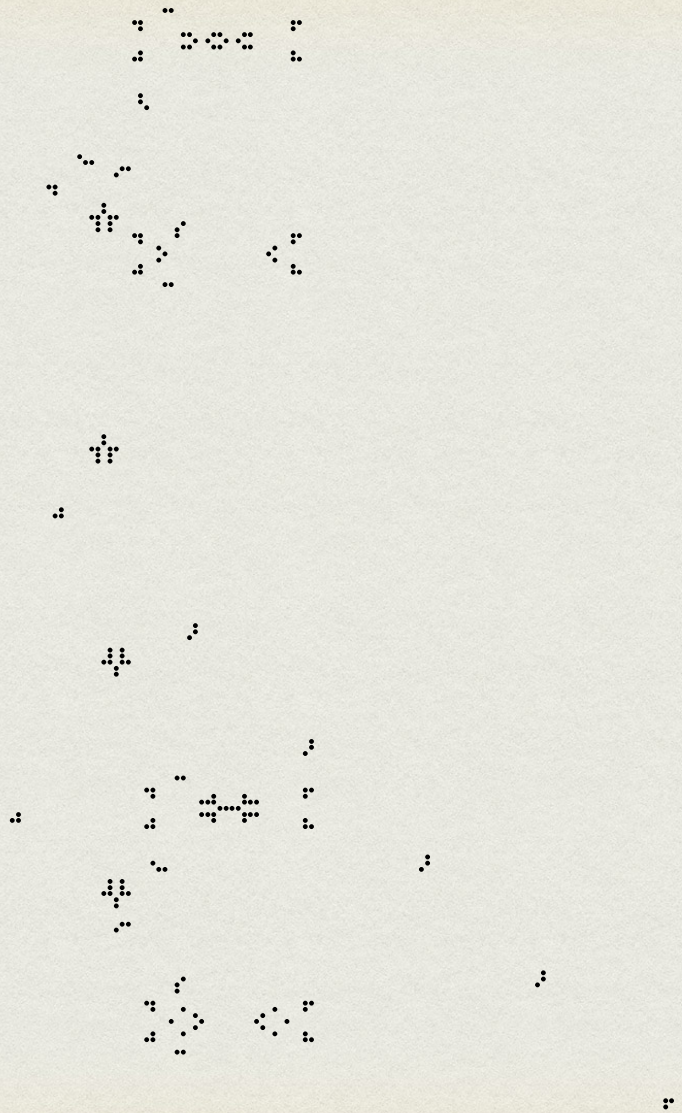
GLIDER GUN A COMPOSED

ggaNE
Composed



GLIDER GUN A COMPOSED

ggaSE
Composed

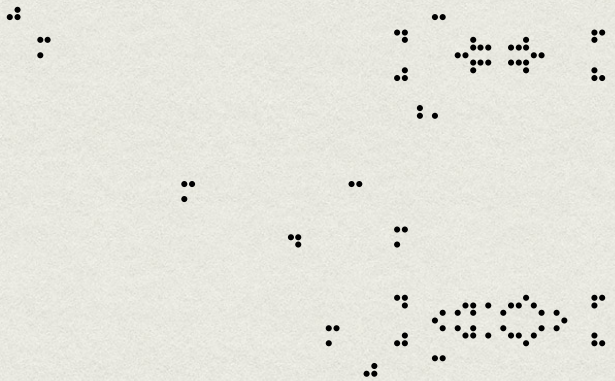


SIMPLIFY GLIDER GUNS COMPOSED

Simplify

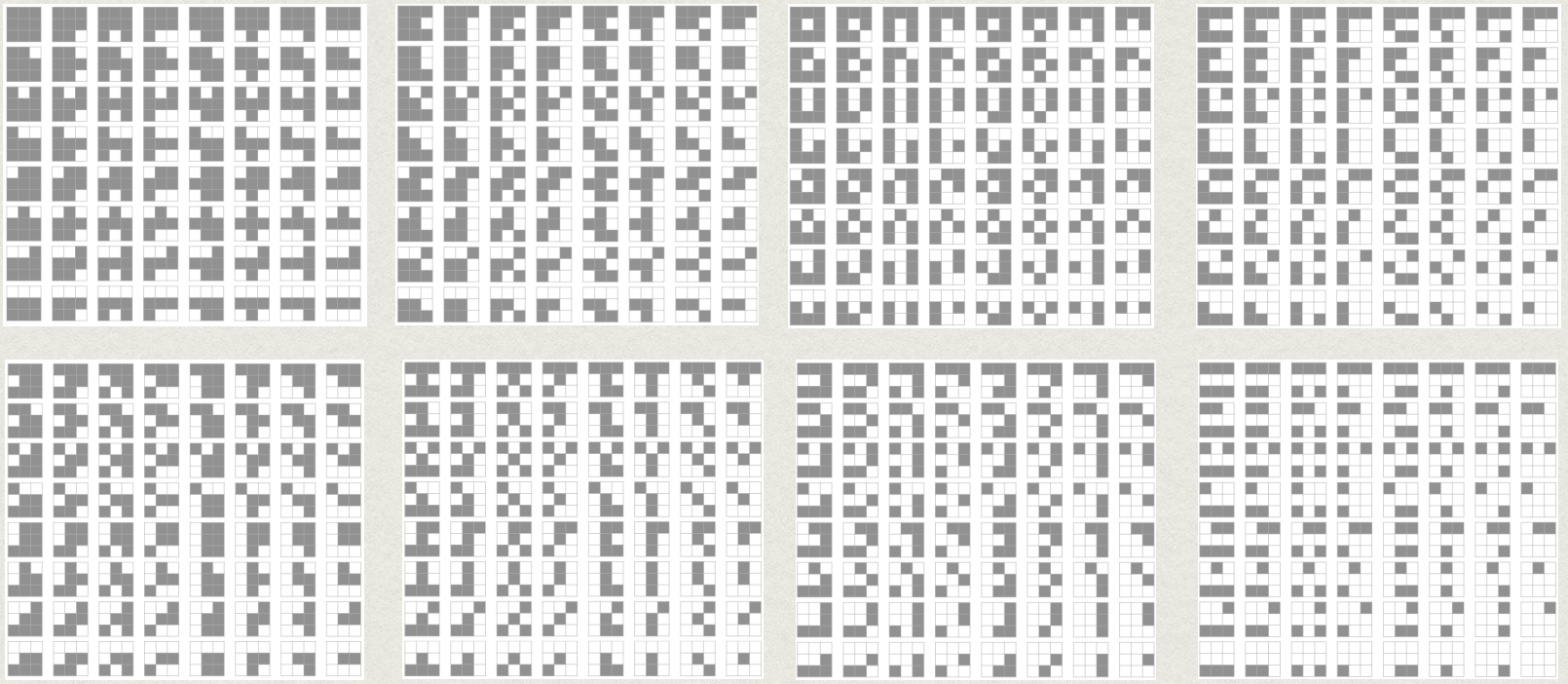
ggaNW

Composed



COMBINACIONES

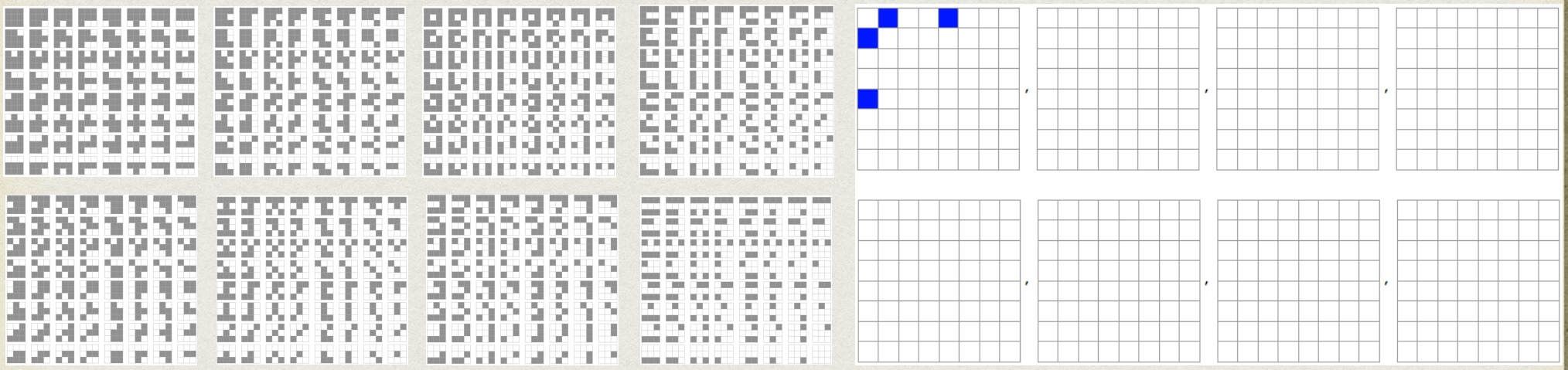
A^S



$$2^{512} = 13407807929942597099574024998205846127479365820592393377723561443721764030073546976801874298166903427690031858186486050853753882811946569946433649006084096$$

COMBINACIONES

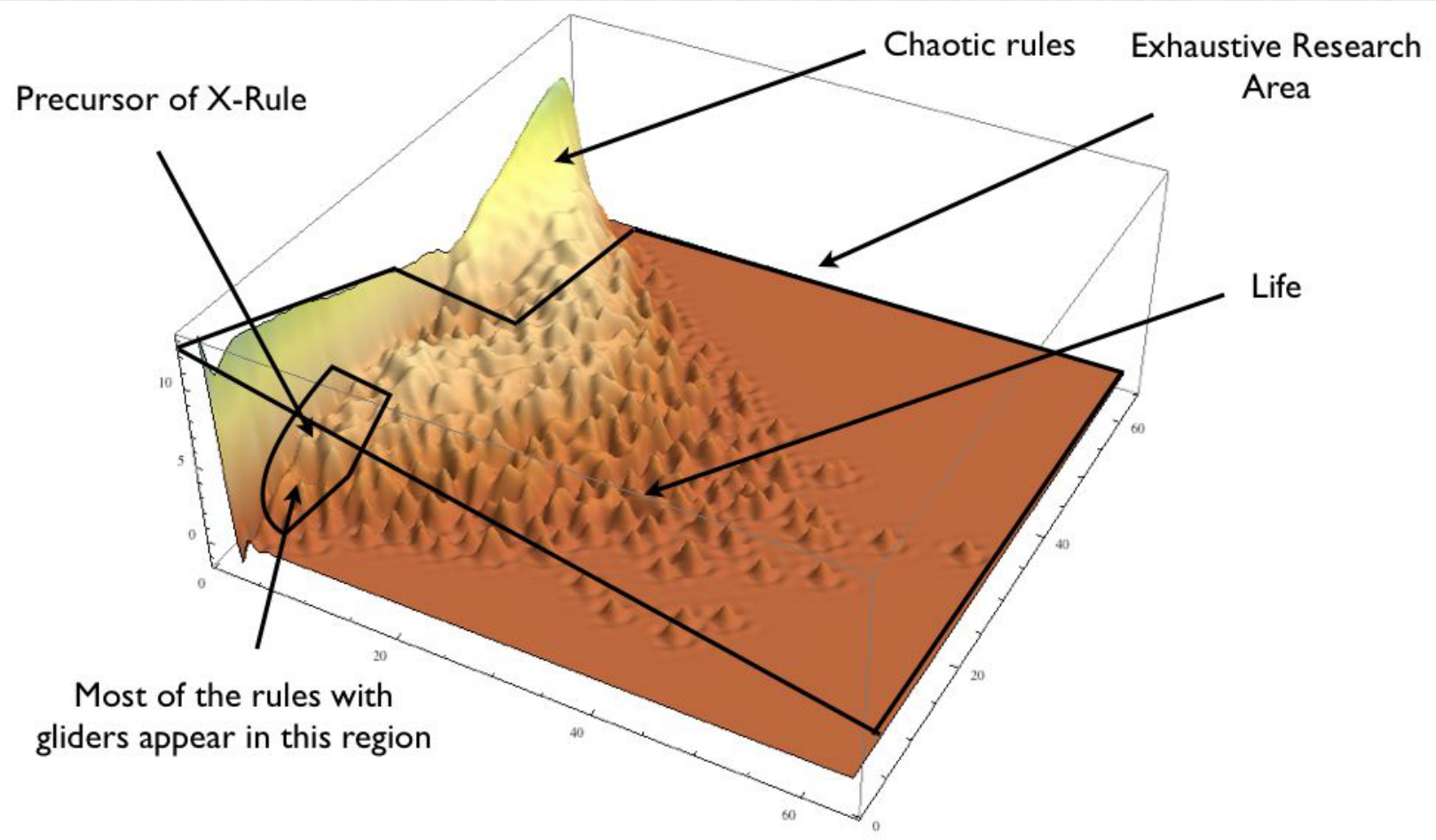
$$A^S$$



$$2^{102} = 4656994643364900608409 6$$

RESEARCH GLIDER METHOD

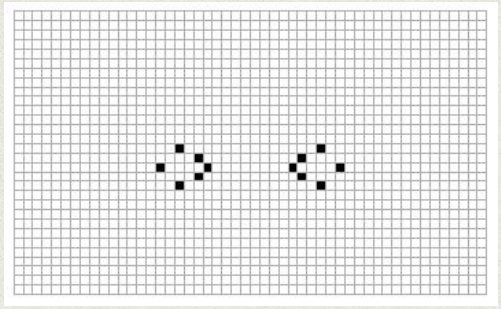
13000 rules generated



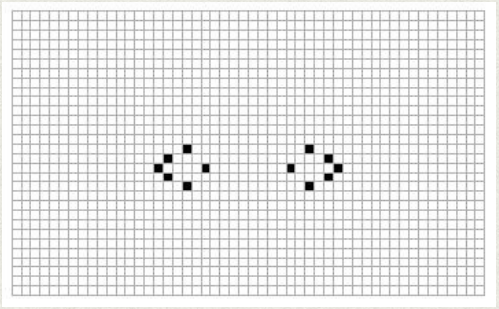
From where we found 71 rules that have gliders

RESEARCH GLIDER METHOD

- From 71 rules that have gliders by experimental computer we detected one that show bouncing behavior



23 steps after



This aspect was interesting because we think that could be possible build a structure that show periodic collision and eventually with some modifications to the rule that collision could gives us a glider.

RESEARCH GLIDER GUN METHOD

- By computer simulation we find the left and right reflector and build the periodic collision structure.
- We try to do configuration changes like open distances between reflector but no gliders emerge.

RESEARCH GLIDER GUN METHOD

- We star changing the rule with the two considerations:

  Preserve periodic collision structure

  Produce ejected gliders

RESEARCH GLIDER GUN METHOD

- Was detectec 11 mutations that accomplish this. Was not consider Isotropic form.
- Generation of random rules from 2^{11} posibilities
- Computer detection of glider gun from random rules.
- Between rules 3000-4000 glider b appear.
- Repeat the process with differ gap between reflectors, and glider a appear.
- We had X-Rule

1. Was detected 11 mutations that accomplishment this.
Was NOT consider Isotropic form.

2. We make a program that generate randomly a determined number
from the population of 2^{11} rules.

3. For each of randomly generated rule this program check automatically
for gliders at generation 100 from a periodic collision like initial condition.

4. Was running this process taking 1000 rules each time,
until appear a rule that eject a glider: the glider gun "b". This rule
appear between 3000 and 4000 rules.

5. One more time was running all this process with different Initial condition: the same
Periodic Collision Structure]--> <--[but with different gap.

6. The rule bshow glider gun "a" with this new initial
condition. Another rules before and after our rule also show glider
gun "a". But we selected this rule because it
supported two glider guns: glider gun "b" and glider gun "a".

In this Way was found X-Rule

RESEARCH GLIDER METHOD

Text

MISCELLANEAS

ggbN
Composed