Curious Computation Models

CONNECTIONS workshop 2019
by fuzzy binaires

Gidon Ernst

SALSA VERDE

1 Bund glatte Petersilie, 1 Bund Basilikum, 1 Bund Minze, 50 g Cornichons, 25 g Kapern, 1 Knoblauchzehe, 1 TL Dijonsenf, ca. 10 EL Olivenöl (je nach Größe der Kräuterbunde), 2 EL Rotweinessig, Salz, schwarzer Pfeffer, Zucker

1 Petersilie, Basilikum und Minze von den Stielen zupfen und sehr fein schneiden. Cornichons und Kapern fein hacken. Knoblauch pellen und ebenfalls fein hacken. Alles in einer Schüssel vermischen.

2 Senf, Olivenöl und Essig untermischen. 10 Minuten ziehen lassen und mit Salz, Pfeffer und einer kräftigen Prise Zucker würzen.

an a*lgorithm* is
a sequence of *instructions*
to be *executed*
by a *computer*

Ada Lovelace

Diagram for the computation by the Engine of the Numbers of Bernoulli. See Note G. (page 722 *et seq.*)

Number of Operation.	Nature of Operation.	Variables acted upon.	Variables receiving results.	Indication of change in the value on any Variable.	Statement of Results.
1	×	${}^1V_2 \times {}^1V_3$	${}^1V_4, {}^1V_5, {}^1V_6$	$\left\{\begin{matrix}{}^1V_2 = {}^1V_2 \\ {}^1V_3 = {}^1V_3\end{matrix}\right\}$	$= 2n$
2	−	${}^1V_4 - {}^1V_1$	${}^2V_4$	$\left\{\begin{matrix}{}^1V_4 = {}^2V_4 \\ {}^1V_1 = {}^1V_1\end{matrix}\right\}$	$= 2n - 1$
3	+	${}^1V_5 + {}^1V_1$	${}^2V_5$	$\left\{\begin{matrix}{}^1V_5 = {}^2V_5 \\ {}^1V_1 = {}^1V_1\end{matrix}\right\}$	$= 2n + 1$
4	÷	${}^2V_5 \div {}^2V_4$	${}^1V_{11}$	$\left\{\begin{matrix}{}^2V_5 = {}^0V_5 \\ {}^2V_4 = {}^0V_4\end{matrix}\right\}$	$= \frac{2n-1}{2n+1}$
5	÷	${}^1V_{11} \div {}^1V_2$	${}^2V_{11}$	$\left\{\begin{matrix}{}^1V_{11} = {}^2V_{11} \\ {}^1V_2 = {}^1V_2\end{matrix}\right\}$	$= \frac{1}{2} \cdot \frac{2n-1}{2n+1}$
6	−	${}^0V_{13} - {}^2V_{11}$	${}^1V_{13}$	$\left\{\begin{matrix}{}^2V_{11} = {}^0V_{11} \\ {}^0V_{13} = {}^1V_{13}\end{matrix}\right\}$	$= -\frac{1}{2} \cdot \frac{2n-1}{2n+1} = A_0$
7	−	${}^1V_3 - {}^1V_1$	${}^1V_{10}$	$\left\{\begin{matrix}{}^1V_3 = {}^1V_3 \\ {}^1V_1 = {}^1V_1\end{matrix}\right\}$	$= n - 1\ (= 3)$
8	+	${}^1V_2 + {}^0V_7$	${}^1V_7$	$\left\{\begin{matrix}{}^1V_2 = {}^1V_2 \\ {}^0V_7 = {}^1V_7\end{matrix}\right\}$	$= 2 + 0 = 2$
9	÷	${}^1V_6 \div {}^1V_7$	${}^3V_{11}$	$\left\{\begin{matrix}{}^1V_6 = {}^1V_6 \\ {}^0V_{11} = {}^3V_{11}\end{matrix}\right\}$	$= \frac{2n}{2} = A_1$
10	×	${}^1V_{21} \times {}^3V_{11}$	${}^1V_{12}$	$\left\{\begin{matrix}{}^1V_{21} = {}^1V_{21} \\ {}^3V_{11} = {}^3V_{11}\end{matrix}\right\}$	$= B_1 \cdot \frac{2n}{2} = B_1 A_1$
11	+	${}^1V_{12} + {}^1V_{13}$	${}^2V_{13}$	$\left\{\begin{matrix}{}^1V_{12} = {}^0V_{12} \\ {}^1V_{13} = {}^2V_{13}\end{matrix}\right\}$	$= -\frac{1}{2} \cdot \frac{2n-1}{2n+1} + B_1 \cdot \frac{2n}{2}$
12	−	${}^1V_{10} - {}^1V_1$	${}^2V_{10}$	$\left\{\begin{matrix}{}^1V_{10} = {}^2V_{10} \\ {}^1V_1 = {}^1V_1\end{matrix}\right\}$	$= n - 2\ (= 2)$
13	−	${}^1V_6 - {}^1V_1$	${}^2V_6$	$\left\{\begin{matrix}{}^1V_6 = {}^2V_6 \\ {}^1V_1 = {}^1V_1\end{matrix}\right\}$	$= 2n - 1$
14	+	${}^1V_1 + {}^1V_7$	${}^2V_7$	$\left\{\begin{matrix}{}^1V_1 = {}^1V_1 \\ {}^1V_7 = {}^2V_7\end{matrix}\right\}$	$= 2 + 1 = 3$
15	÷	${}^2V_6 \div {}^2V_7$	${}^1V_8$	$\left\{\begin{matrix}{}^2V_6 = {}^2V_6 \\ {}^2V_7 = {}^2V_7\end{matrix}\right\}$	$= \frac{2n-1}{3}$
16	×	${}^1V_8 \times {}^3V_{11}$	${}^4V_{11}$	$\left\{\begin{matrix}{}^1V_8 = {}^0V_8 \\ {}^3V_{11} = {}^4V_{11}\end{matrix}\right\}$	$= \frac{2n}{2} \cdot \frac{2n-1}{3}$
17	−	${}^2V_6 - {}^1V_1$	${}^3V_6$	$\left\{\begin{matrix}{}^2V_6 = {}^3V_6 \\ {}^1V_1 = {}^1V_1\end{matrix}\right\}$	$= 2n - 2$
18	+	${}^1V_1 + {}^2V_7$	${}^3V_7$	$\left\{\begin{matrix}{}^2V_7 = {}^3V_7 \\ {}^1V_1 = {}^1V_1\end{matrix}\right\}$	$= 3 + 1 = 4$
19	÷	${}^3V_6 \div {}^3V_7$	${}^1V_9$	$\left\{\begin{matrix}{}^3V_6 = {}^3V_6 \\ {}^3V_7 = {}^3V_7\end{matrix}\right\}$	$= \frac{2n-2}{4}$
20	×	${}^1V_9 \times {}^4V_{11}$	${}^5V_{11}$	$\left\{\begin{matrix}{}^1V_9 = {}^0V_9 \\ {}^4V_{11} = {}^5V_{11}\end{matrix}\right\}$	$= \frac{2n}{2} \cdot \frac{2n-1}{3} \cdot \frac{2n-2}{4} = A_3$
21	×	${}^1V_{22} \times {}^5V_{11}$	${}^0V_{12}$	$\left\{\begin{matrix}{}^1V_{22} = {}^1V_{22} \\ {}^0V_{12} = {}^2V_{12}\end{matrix}\right\}$	$= B_3 \cdot \frac{2n}{2} \cdot \frac{2n-1}{3} \cdot \frac{2n-2}{3} = B_3 A_3$
22	+	${}^2V_{12} + {}^2V_{13}$	${}^3V_{13}$	$\left\{\begin{matrix}{}^2V_{12} = {}^0V_{12} \\ {}^2V_{13} = {}^3V_{13}\end{matrix}\right\}$	$= A_0 + B_1 A_1 + B_3 A_3$
23	−	${}^2V_{10} - {}^1V_1$	${}^3V_{10}$	$\left\{\begin{matrix}{}^2V_{10} = {}^3V_{10} \\ {}^1V_1 = {}^1V_1\end{matrix}\right\}$	$= n - 3\ (= 1)$
		Here follows a repetition of Operations thirteen to twenty-three.			
24	+	${}^4V_{13} + {}^0V_{24}$	${}^1V_{24}$	$\left\{\begin{matrix}{}^4V_{13} = {}^0V_{13} \\ {}^0V_{24} = {}^1V_{24}\end{matrix}\right\}$	$= B_7$
25	+	${}^1V_1 + {}^1V_3$	${}^1V_3$	$\left\{\begin{matrix}{}^1V_1 = {}^1V_1 \\ {}^1V_3 = {}^1V_3 \\ {}^5V_6 = {}^0V_6 \\ {}^5V_7 = {}^0V_7\end{matrix}\right\}$	$= n + 1 = 4 + 1 = 5$ by a Variable-card. by a Variable card.

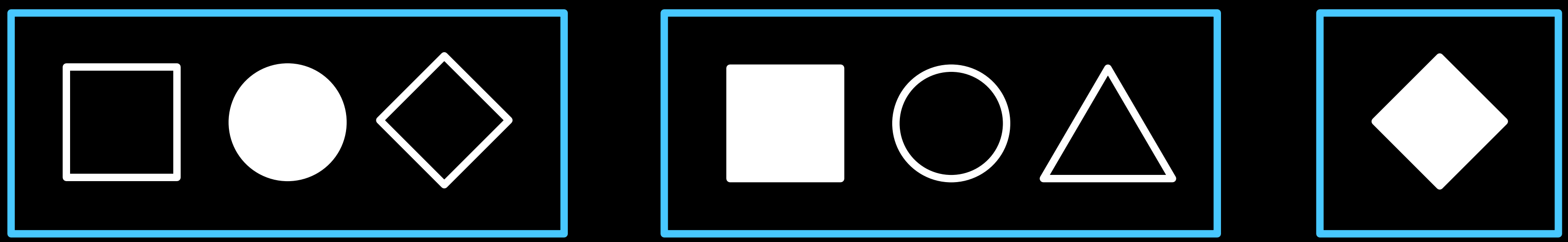
Number of Operation.	Data. ${}^1V_1$	Data. ${}^1V_2$	Data. ${}^1V_3$	Working Variables. ${}^0V_4$	${}^0V_5$	${}^0V_6$	${}^0V_7$	${}^0V_8$	${}^0V_9$	${}^0V_{10}$	${}^0V_{11}$	${}^0V_{12}$	${}^0V_{13}$	Result Variables. ${}^1V_{21}$ B_1 in a decimal fraction.	${}^1V_{22}$ B_3 in a decimal fraction.	${}^1V_{23}$ B_5 in a decimal fraction.	${}^0V_{24}$
	0001	0002	0004	0000	0000	0000	0000	0000	0000	0000	0000	0000	0000				0000
	1	2	n											B_1	B_3	B_5	B_7
1	...	2	n	$2n$	$2n$	$2n$											
2	1	...	...	$2n-1$													
3	1	...	...	...	$2n+1$												
4	...	...	...	0	0	...	...	...	...	...	$\frac{2n-1}{2n+1}$						
5	...	2	...	...	...	...	...	...	...	...	$\frac{1}{2} \cdot \frac{2n-1}{2n+1}$						
6	...	...	...	...	...	...	...	...	...	...	0	....	$-\frac{1}{2} \cdot \frac{2n-1}{2n+1} = A_0$				
7	1	...	n	...	...	...	...	...	...	$n-1$							
8	...	2	...	...	...	...	2										
9	...	...	...	...	...	$2n$	2	...	...	...	$\frac{2n}{2} = A_1$						
10	...	...	...	...	...	...	...	...	...	...	$\frac{2n}{2} = A_1$	$B_1 \cdot \frac{2n}{2} = B_1 A_1$	....	B_1			
11	...	...	...	...	...	...	...	...	...	...	....	0	$\left\{-\frac{1}{2} \cdot \frac{2n-1}{2n+1} + B_1 \cdot \frac{2n}{2}\right\}$				
12	1	...	...	...	...	...	...	...	...	$n-2$							
13	1	...	...	...	...	$2n-1$											
14	1	...	...	...	...	...	3										
15	...	...	...	...	...	$2n-1$	3	$\frac{2n-1}{3}$									
16	...	...	...	...	...	...	...	0	...	...	$\frac{2n}{2} \cdot \frac{2n-1}{3}$						
17	1	...	...	...	...	$2n-2$											
18	1	...	...	...	...	...	4										
19	...	...	...	...	...	$2n-2$	4	...	$\frac{2n-2}{4}$	...	$\left\{\frac{2n}{2} \cdot \frac{2n-1}{3} \cdot \frac{2n-2}{3} = A_3\right\}$						
20	...	...	...	...	...	...	...	...	0								
21	...	...	...	...	...	...	...	...	...	...	0	$B_3 A_3$	....	......	B_3		
22	...	...	...	...	...	...	...	...	...	...	....	0	$\left\{A_0 + B_1 A_1 + B_3 A_3\right\}$				
23	1	...	...	...	...	...	...	...	...	$n-3$							
24	...	...	...	...	...	...	...	...	...	...	....	....	....	......	......	......	B_7
25	1	...	$n+1$	...	...	0	0										

an a*lgorithm* is
a sequence of *instructions*
to be *executed*
by a *computer*

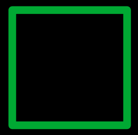
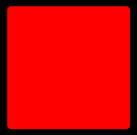
which *problems* can be solved by algorithms?

A simple game

Goal: at least one green symbol in each box

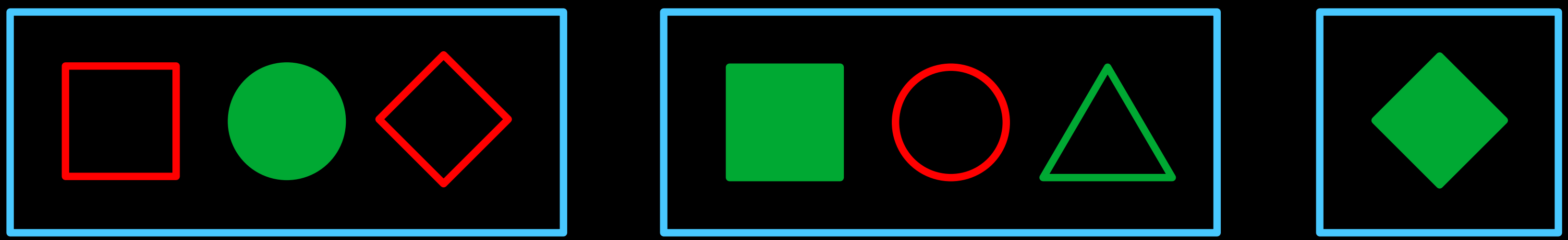


Rules

- two colors: red, green
- if a hollow symbol is red, then the same solid symbol must be green and vice versa
  example:  means 

A simple game: possible solution

Goal: at least one green symbol in each box



Rules

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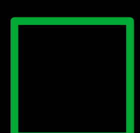
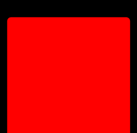
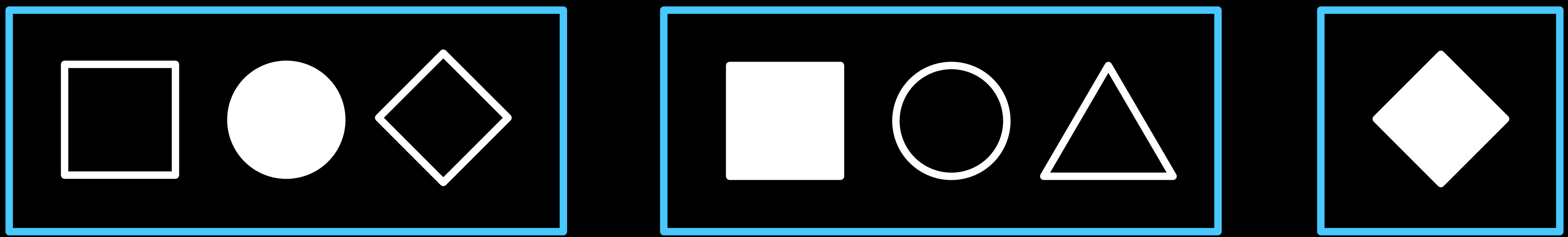
  example:  means 

This game solves logical formulas!

Goal: at least one green symbol in each box



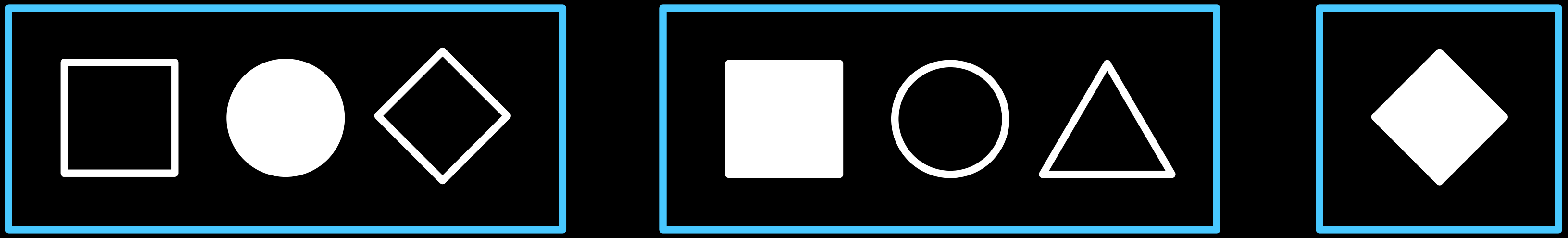
Corresponds to:

(P or ~Q or S) and (~P or Q or R) and (~S)

Credit: Martina Seidl (Uni Linz)

Solving the game

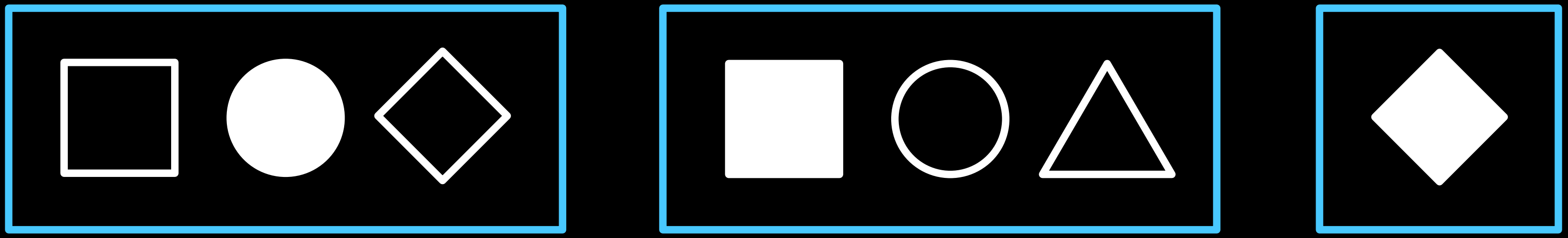
Goal: at least one green symbol in each box



- An example algorithm:
  1) guess the correct answer if one exists
  2) check that the answer solves the game

Solving the game

Goal: at least one green symbol in each box



- Another algorithm:
  1) pick arbitrary colors for the hollow symbols, then set the colors for solid symbols by the rules
  2) check if each box contains a green symbol
  3) repeat if necessary

an a*lgorithm* is
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to be *executed*
by a *computer*

which *problems* can be solved by algorithms?
answer depends on *model of computation*!

Alan Turing

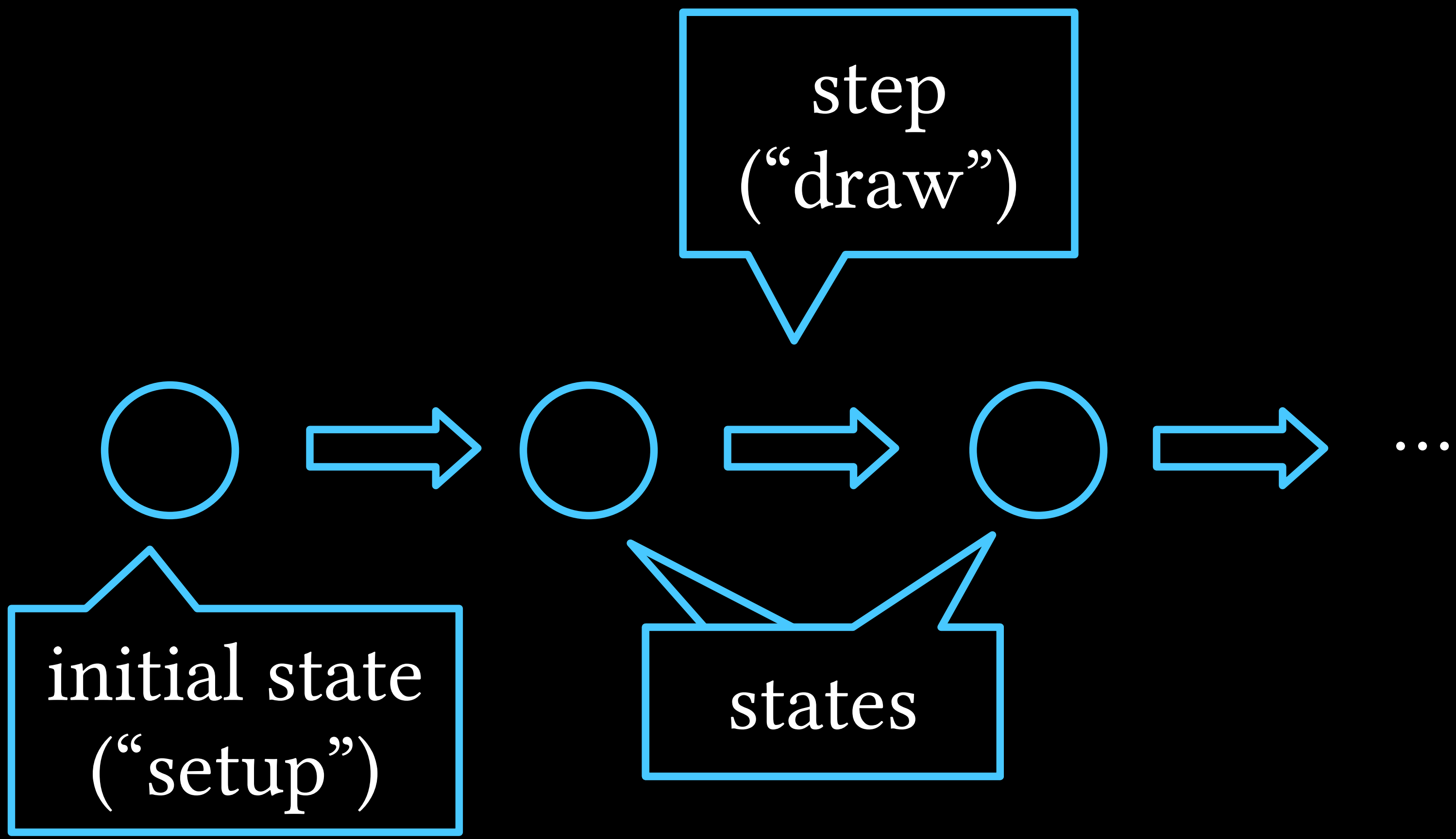
ON COMPUTABLE NUMBERS, WITH AN APPLICATION TO THE ENTSCHEIDUNGSPROBLEM

By A. M. Turing.

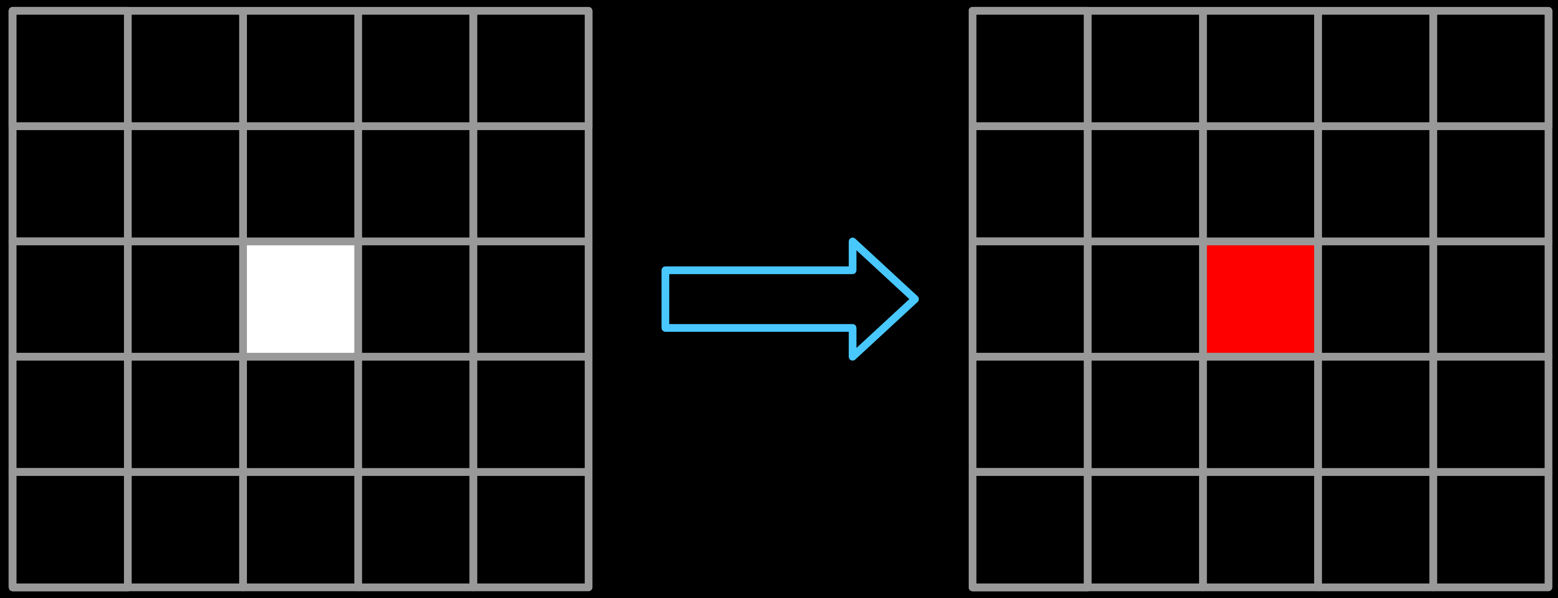
[Received 28 May, 1936.—Read 12 November, 1936.]

Alonzo Church

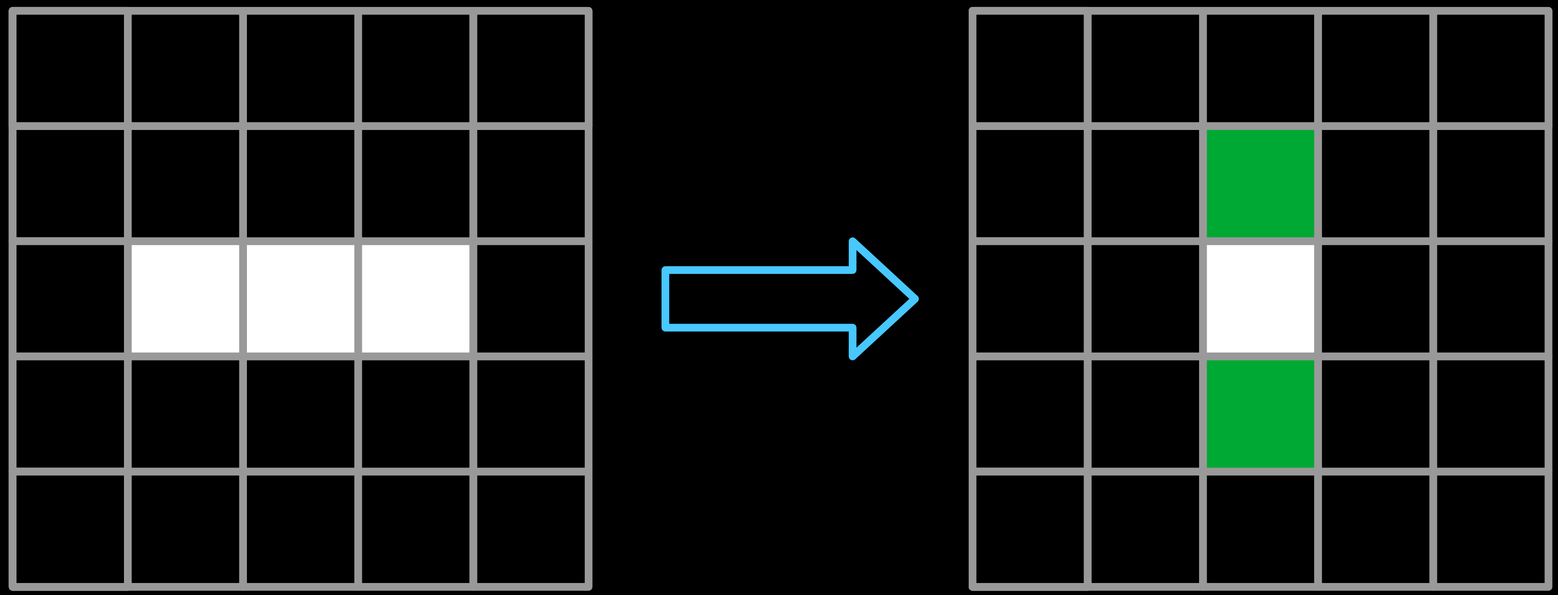
Computation



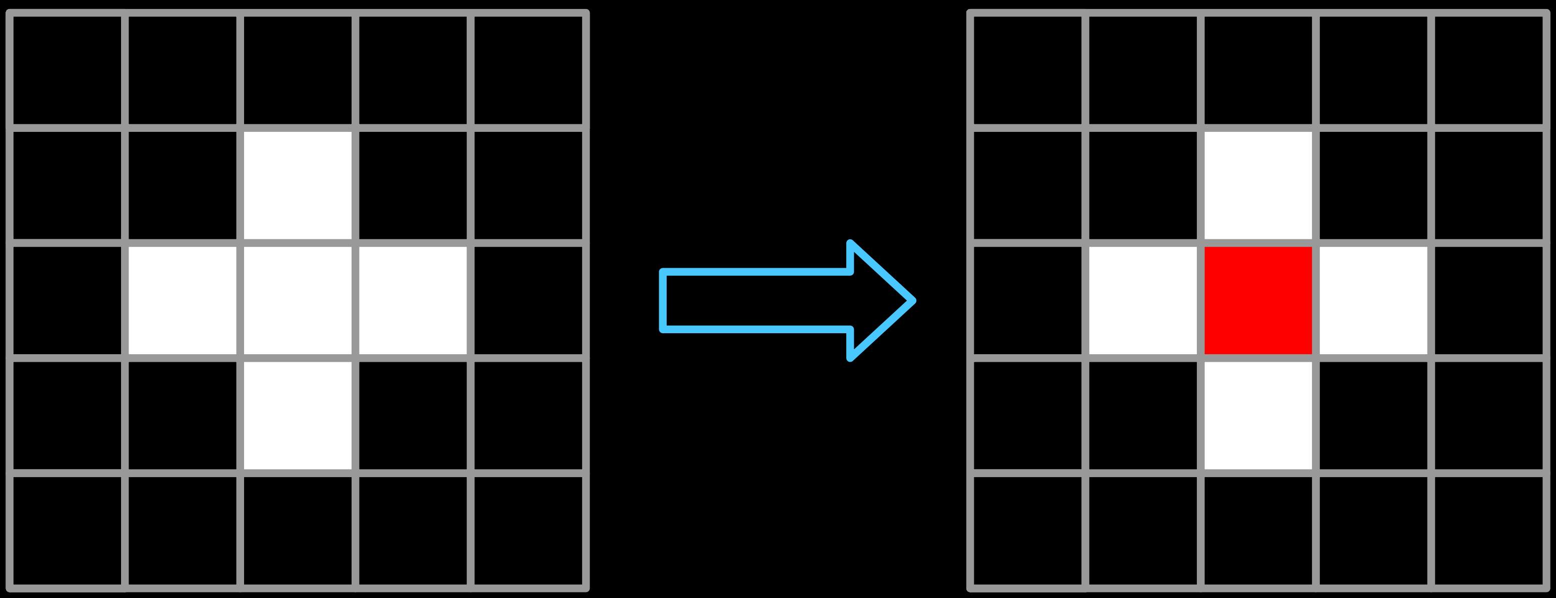
Game of Life

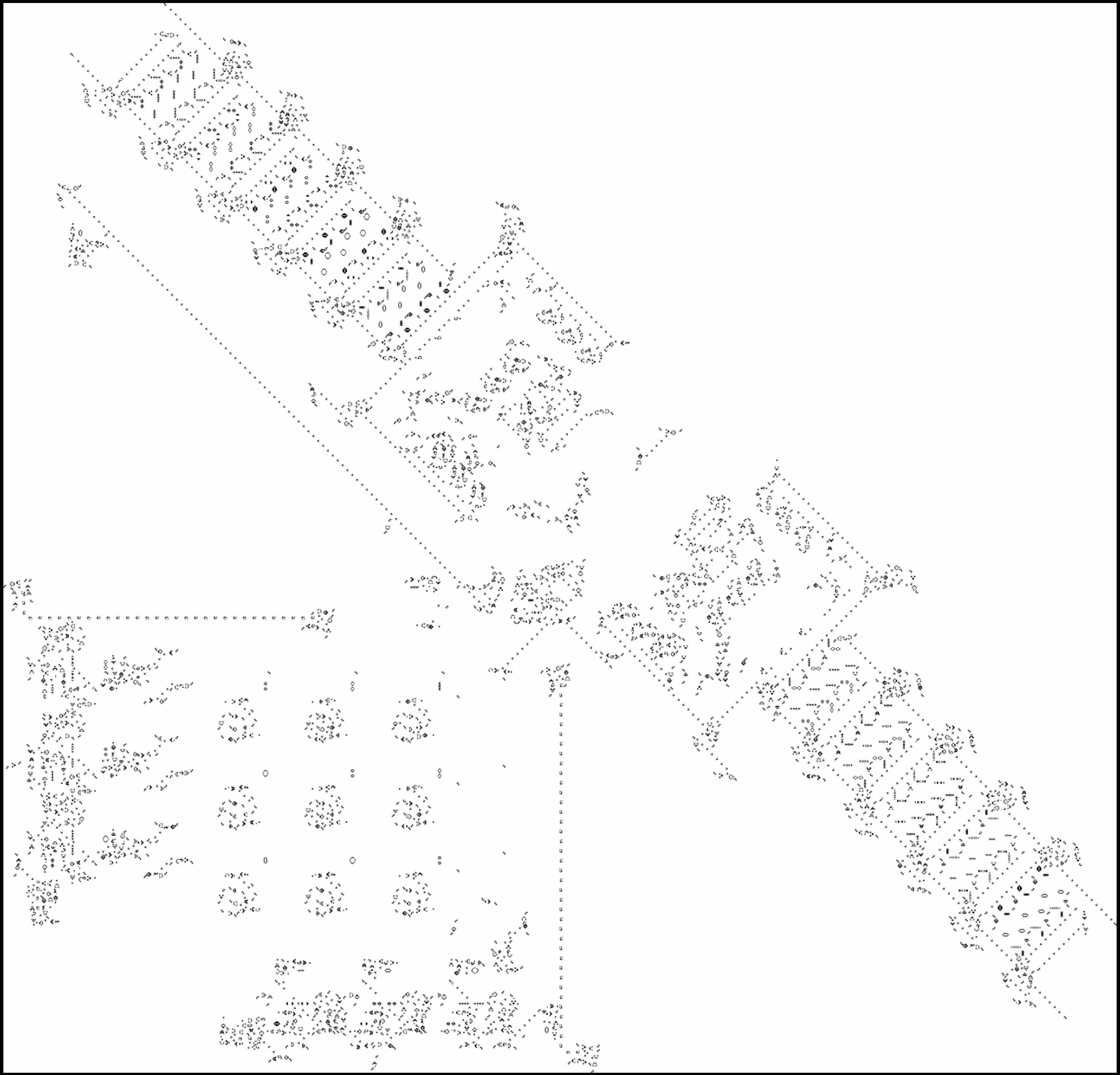


Game of Life



Game of Life





http://www.rendell-attic.org/gol/tm.htm