Twitter Thread by Alan Zucconi

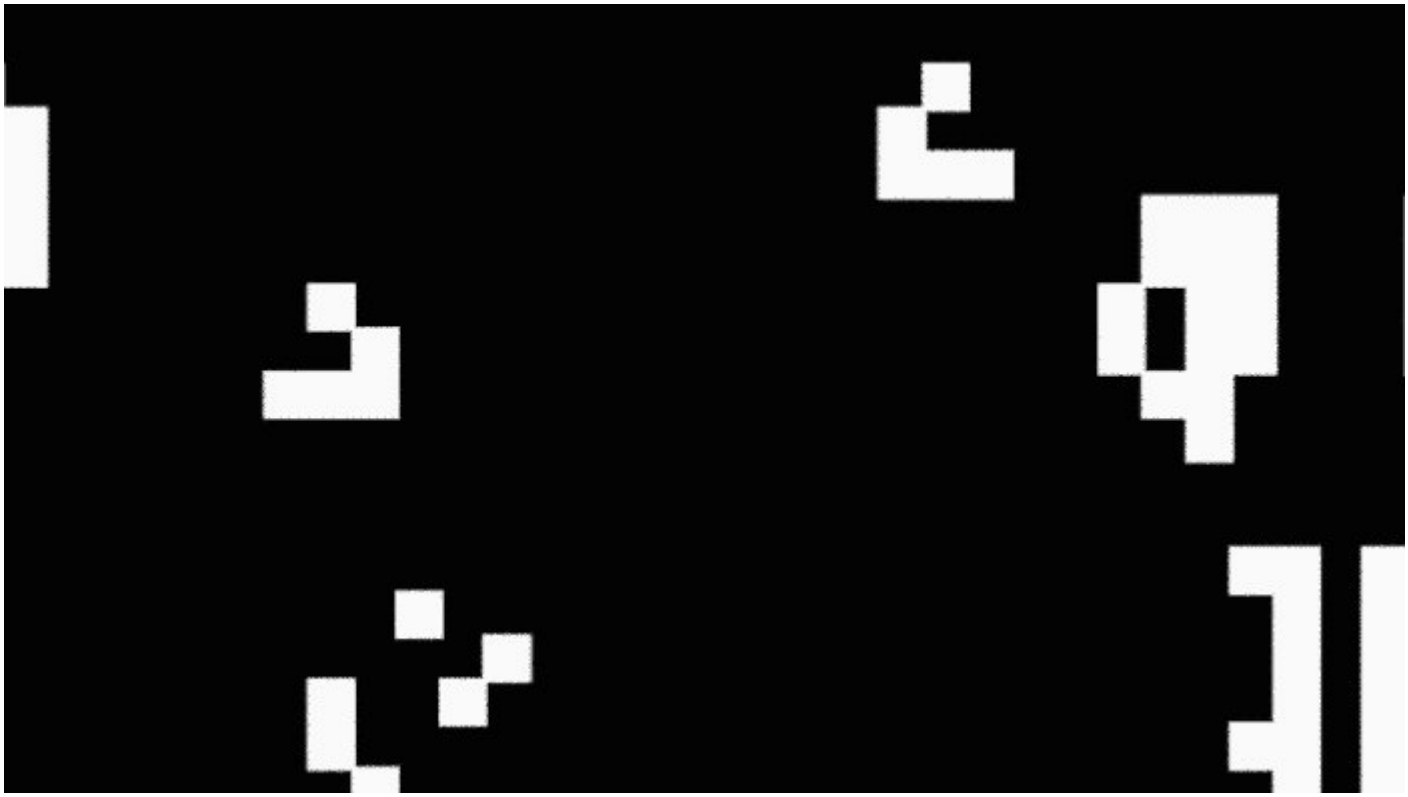
Alan Zucconi
@AlanZucconi

Fifty years have passed since CONWAY'S GAME OF LIFE firstly appeared on a column called "Mathematical Games" on @sciam.

While most Programmers & Computer Science enthusiasts are familiar with it, not many know that the game is actually TURING COMPLETE.

Let's see why. ■■

■■



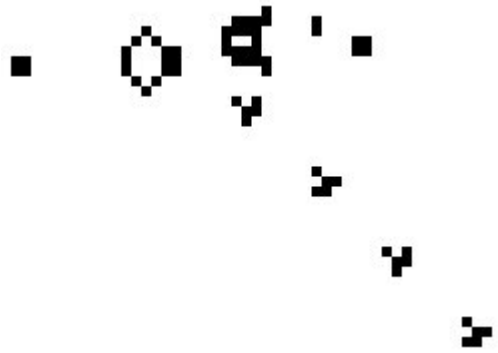
The quickest way to prove that a system is TURING COMPLETE is to show that it allows for the constructions of LOGIC GATES. ■■

So, let's see how the ■■■, ■■ and ■■■ gates can actually be constructed in Conway's Game of Life...

Firstly, we need to find a way to encode binary signals.

One very popular choice is to use a stream of GLIDERS. The so-called GOSPER GLIDER GUN can generated a new glider every 30 generations. ■

Hence, receiving a glider every 30 generations counts as a "1".

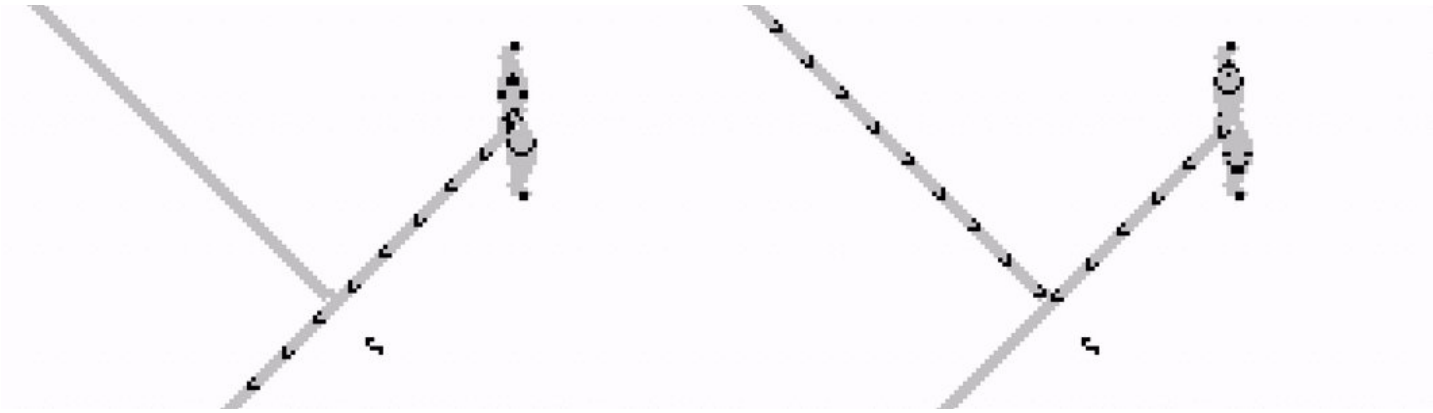


When two GLIDERS hit each other in just the right way, they both get destroyed. ■

This means that a GLIDER GUN can stop an incoming glider stream!

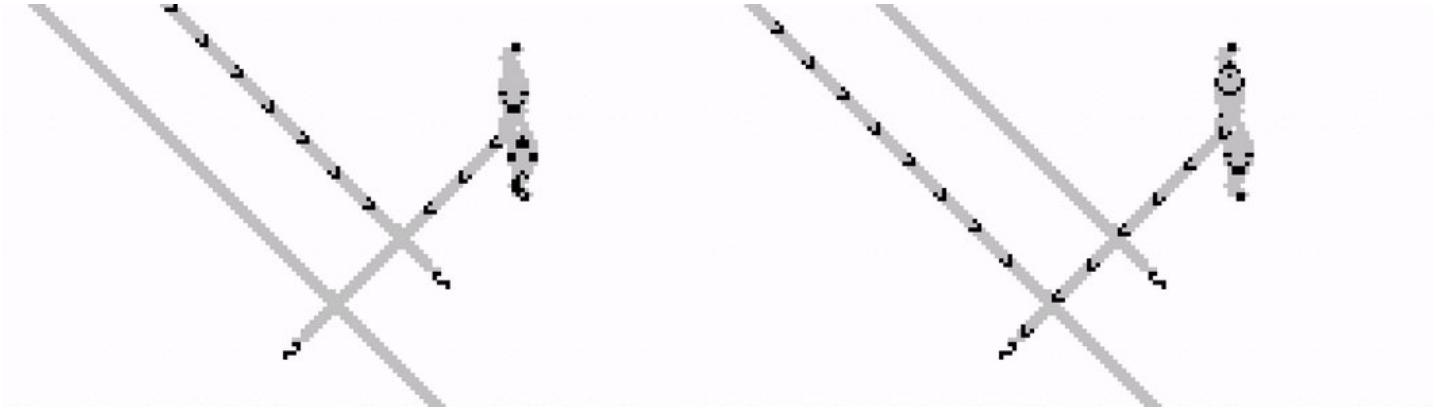
We can exploit this mechanism to simulate a NOT gate:

■■ ■■■ 0 = 1 ■■ ■■■ 1 = 0



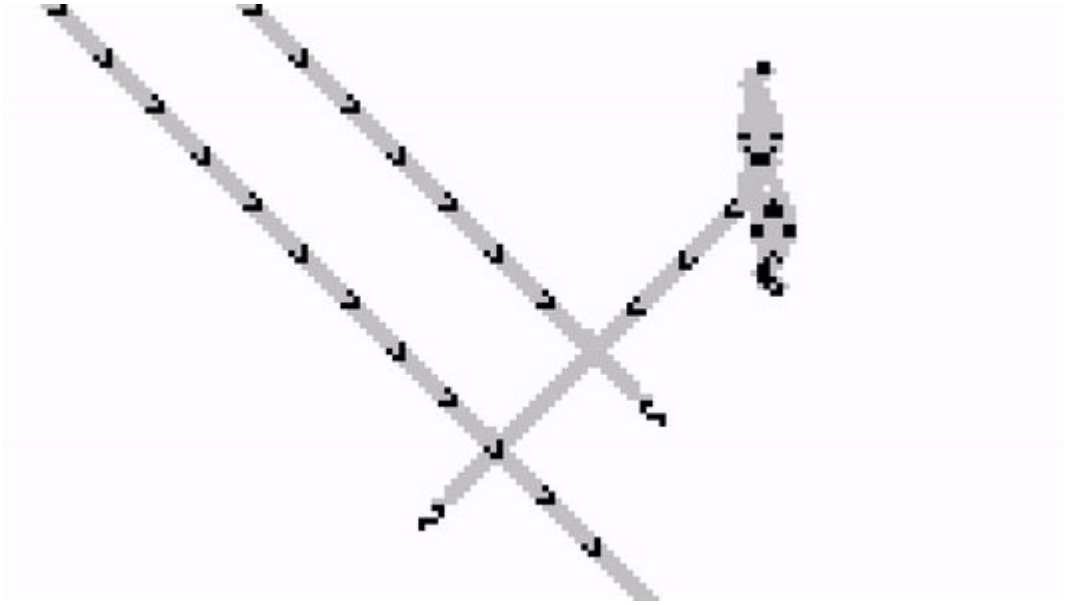
With the same principle, and AND gate can be also constructed by extending a NOT gate.

■■ 0 ■■■ 1 = 0 ■■ 1 ■■■ 0 = 0



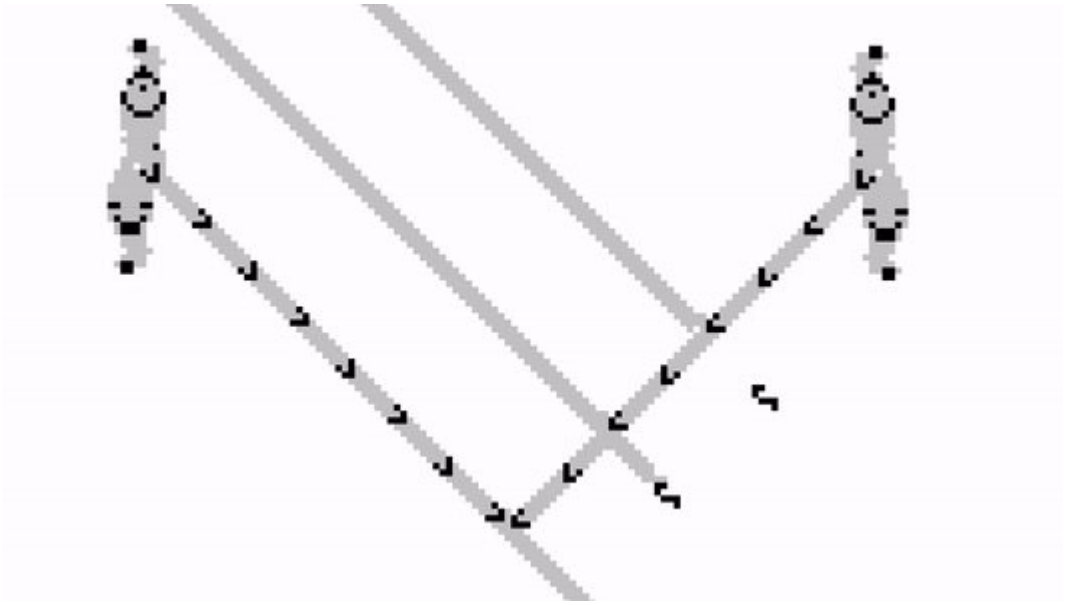
For the glider stream to the right to survive an AND gate, the second input needs to cancel the stream coming from the glider gun to the right.

■■ 1 ■■■ 1 = 1

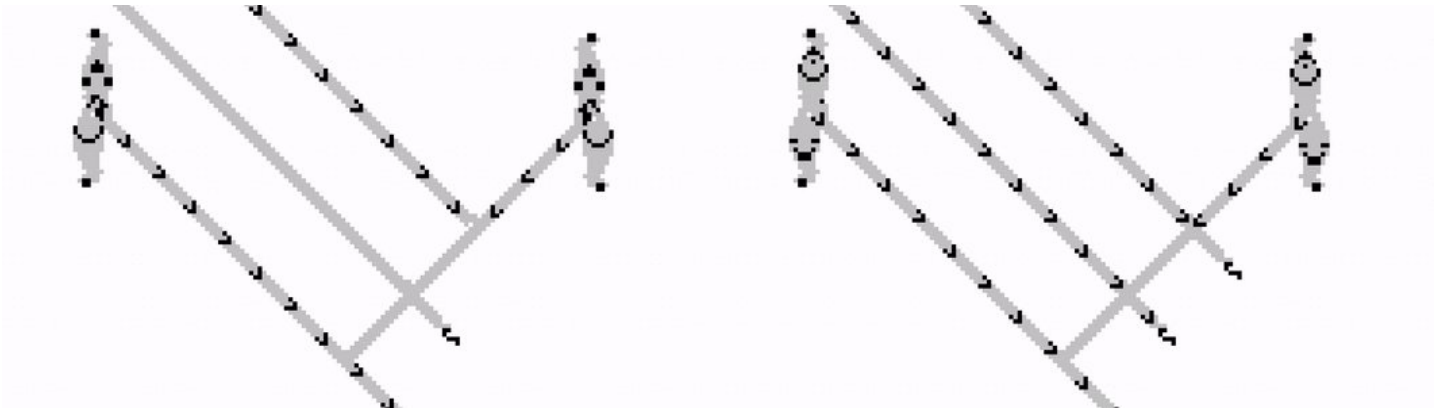


Another small modification allows to construct an OR gate.

■■ 0 ■■ 0 = 0



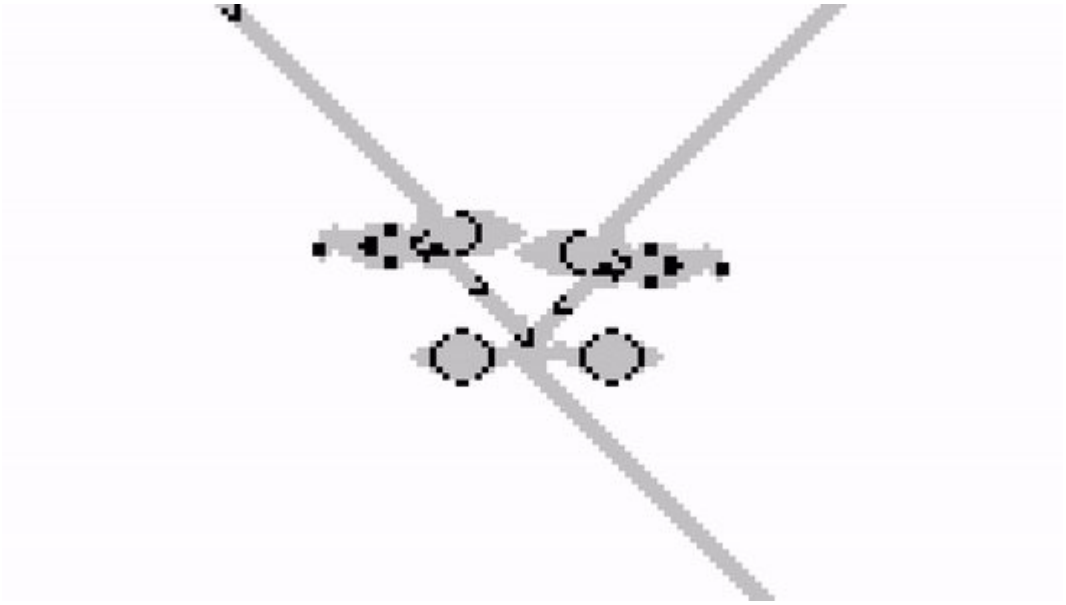
■■ 0 ■■ 1 = 1 ■■ 1 ■■ 1 = 1



The AND, OR & NOT gates are said to be FUNCTIONALLY COMPLETE, as can be used to construct any logic expression.

This is one step away from TURING COMPLETENESS. ■

What we need is a memory block! The pattern below works as a SET-RESET LATCH: a simple 1-bit memory register!



LOGIC GATES & LATCHES are everything needed to build an actual computer. ■■

If you are interested to learn more about this, this short documentary goes into great length to explain the process of building an actual computer in Conway's Game of Life. ■■

https://t.co/7e3LKmGfNi

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