



PyQB

Monga

A game of life

Programming in Python¹

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Lecture XIX: A game of life



A game of life

In 1970, J.H. Conway proposed his **Game of Life**, a simulation on a 2D grid:

- 1 Every cell can be *alive* or *dead*: the game start with a population of alive cells (*seed*)
- 2 any alive cell with less of 2 alive neighbours dies (*underpopulation*)
- 3 any alive cell with more than 3 alive neighbours dies (*overpopulation*)
- 4 any dead cell with exactly 3 alive neighbours becomes alive (*reproduction*)

The game is surprisingly rich: many mathematicians, computer scientists, biologists. . . spent their careers on the emerging patterns!

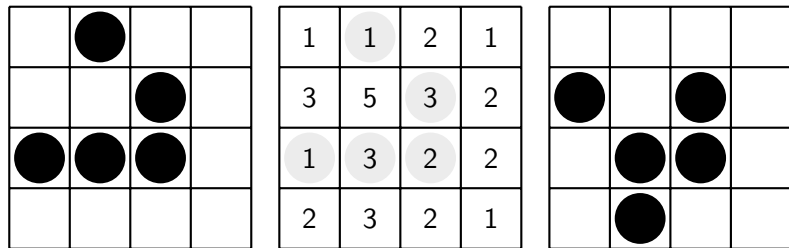
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There are names for many “life forms”: *still lifes*, *oscillators*, *starships*...

A famous starship is the **glider**:



The glider repeats itself in another position after 4 generations.



To implement a Game of Life simulation in Python, we can:

- use a ndarray for the grid
- each cell contains 0 (dead) or 1 (alive)
- for simplicity we can add a “border” of zeros

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



Avoiding loops

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For a 1-D array X

0	1	1	0	1	0
---	---	---	---	---	---

All the neighbours on the right $X[2:]$

0	1	1	0	1	0
---	---	---	---	---	---

All the neighbours on the left $X[:-2]$

What does $X[2:] + X[:-2]$ represent? The sum is (yellow) element by (yellow) element, the result is: $[1, 1, 2, 0]$

Can you think to a similar solution for the 2-D case?

Avoiding loops



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

`X[1:-1, 2:]`

Avoiding loops



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

`X[2:,2:]`

Avoiding loops



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

`X[2: , 1:-1]`

Avoiding loops



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

$X[2:, 1:-1]$

And other 5 matrices...



Avoiding loops

X					
0	0	0	0	0	0
0	0	1	0	0	0
0	0	0	1	0	0
0	1	1	1	0	0
0	0	0	0	0	0
0	0	0	0	0	0

$$X == 1$$

N					
0	0	0	0	0	0
0	1	1	2	1	0
0	3	5	3	2	0
0	1	3	2	2	0
0	2	3	2	1	0
0	0	0	0	0	0

$$N > 3$$

Death by overpopulation: $X[(X == 1) \& (N > 3)] = 0$
(empty in this case!)

