Smith College
Computer Science

CSC231—Assembly

Week #10 — Fall 2017

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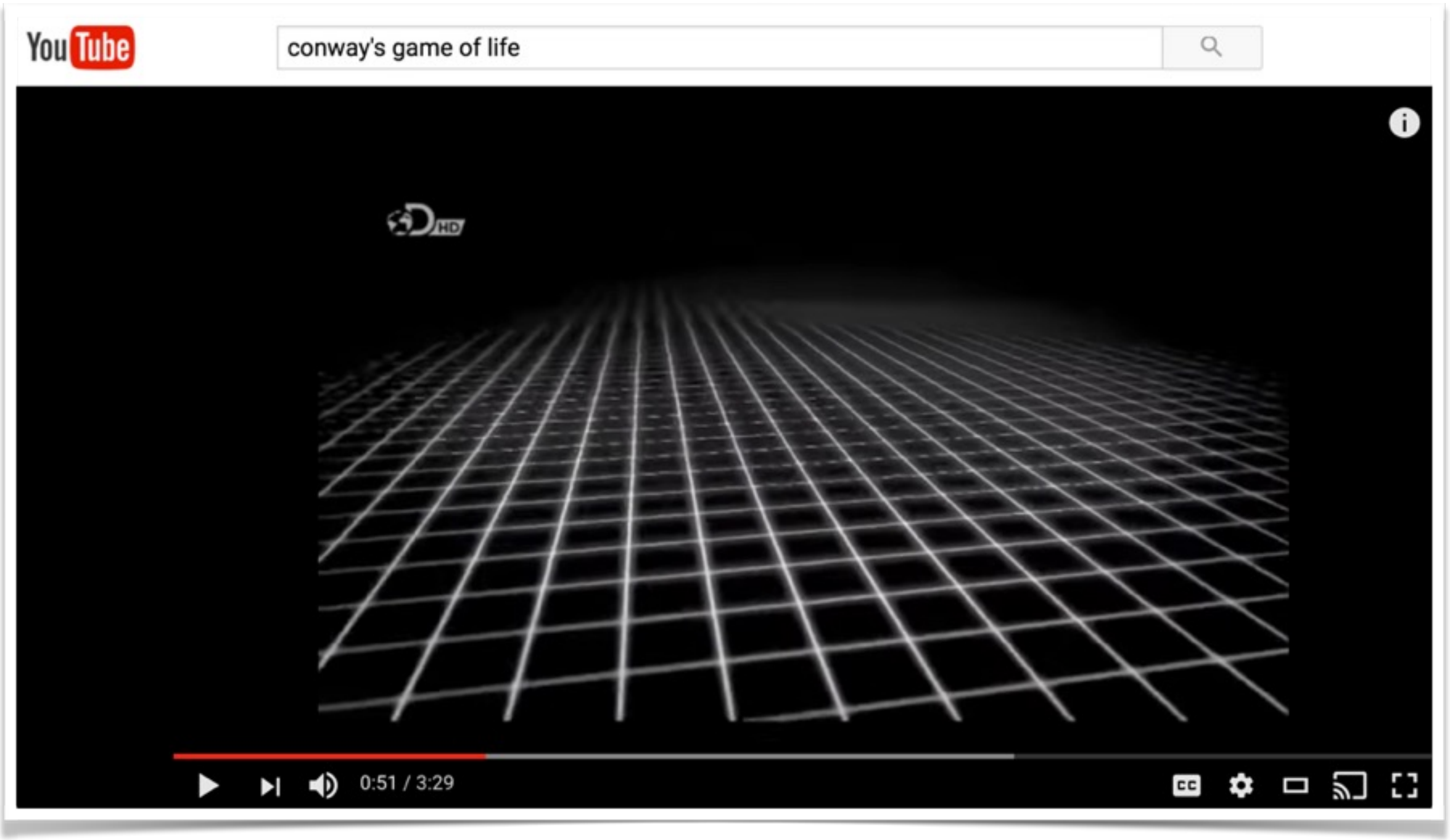
2 Videos to Start With

https://www.youtube.com/watch?v=FdMzngWchDk

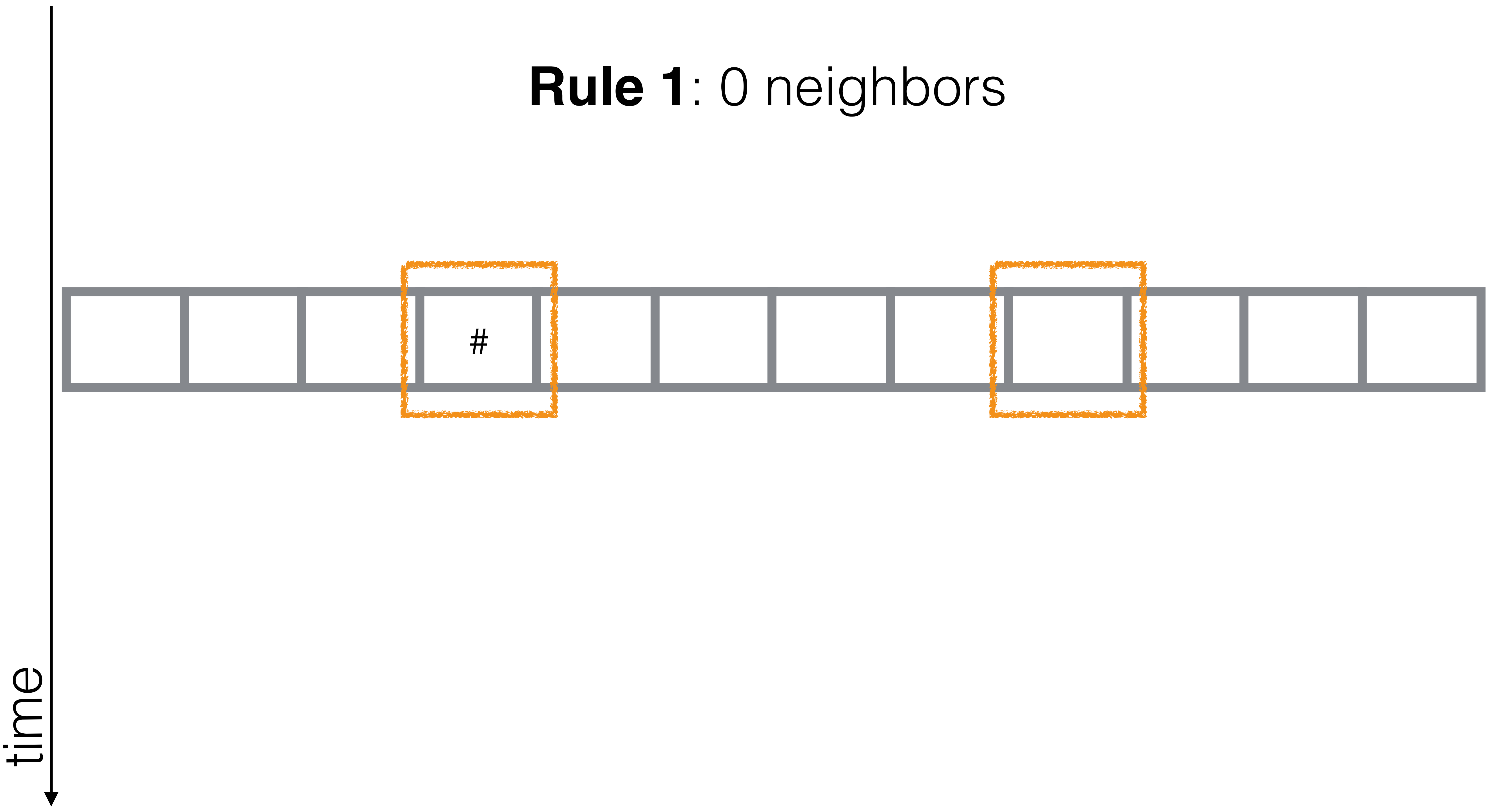
https://www.youtube.com/watch?v=k2IZ1qsx4CM



https://www.youtube.com/watch?v=CgOcEZinQ2I

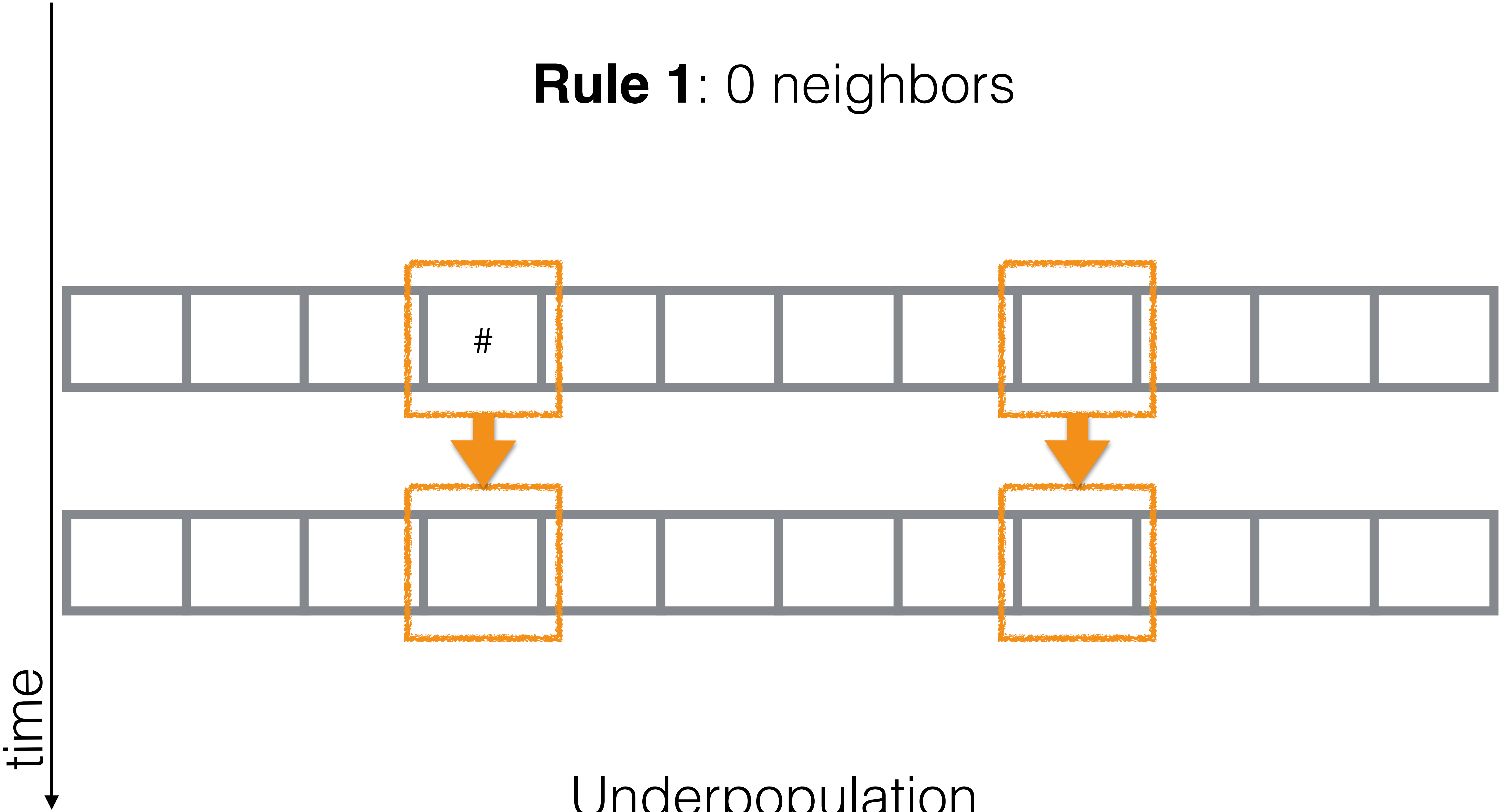
1-Dimensional Game of Life

Rules of 1D-Life



Rules of 1D-Life

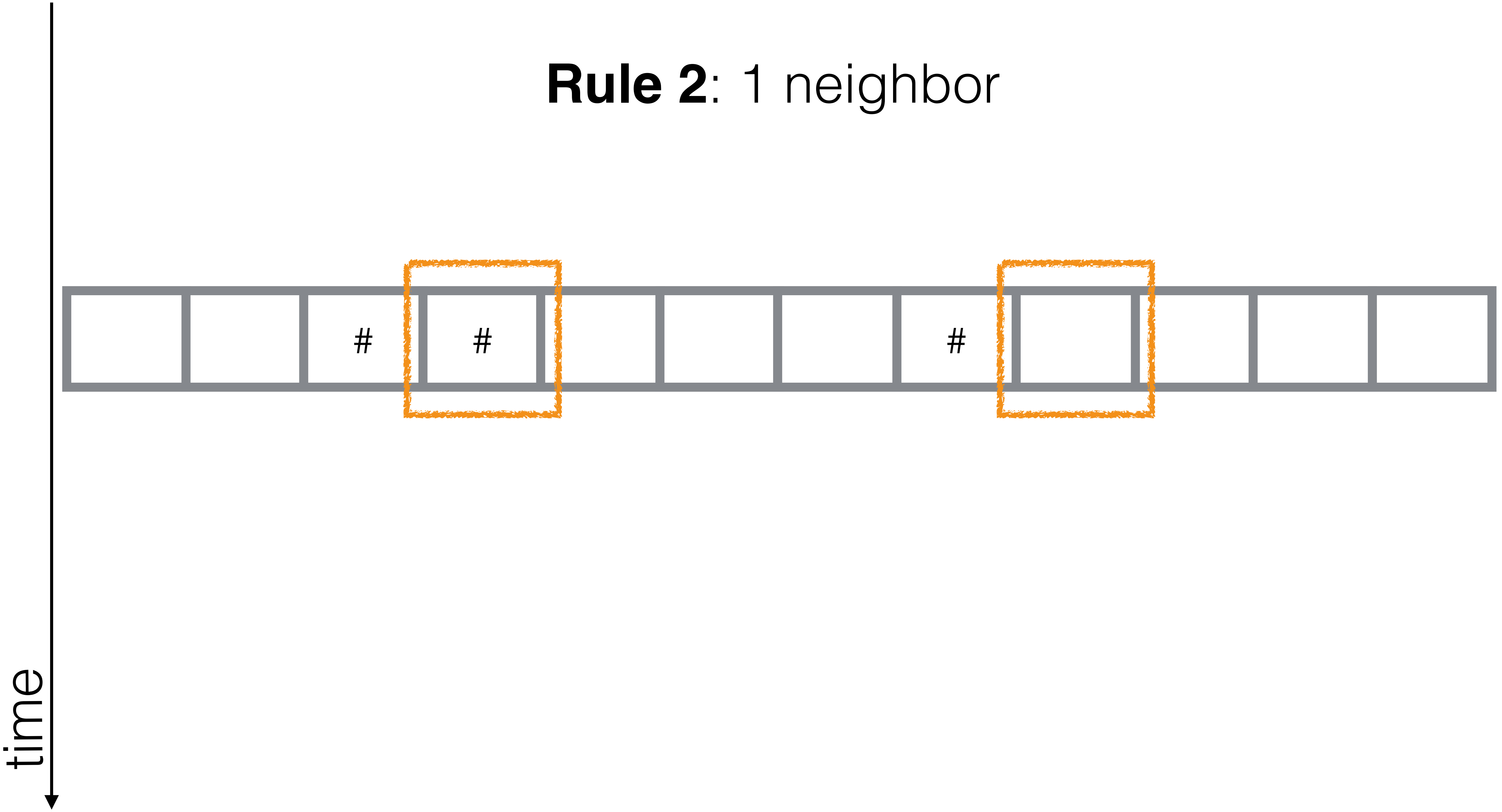
Rule 1: 0 neighbors



Underpopulation

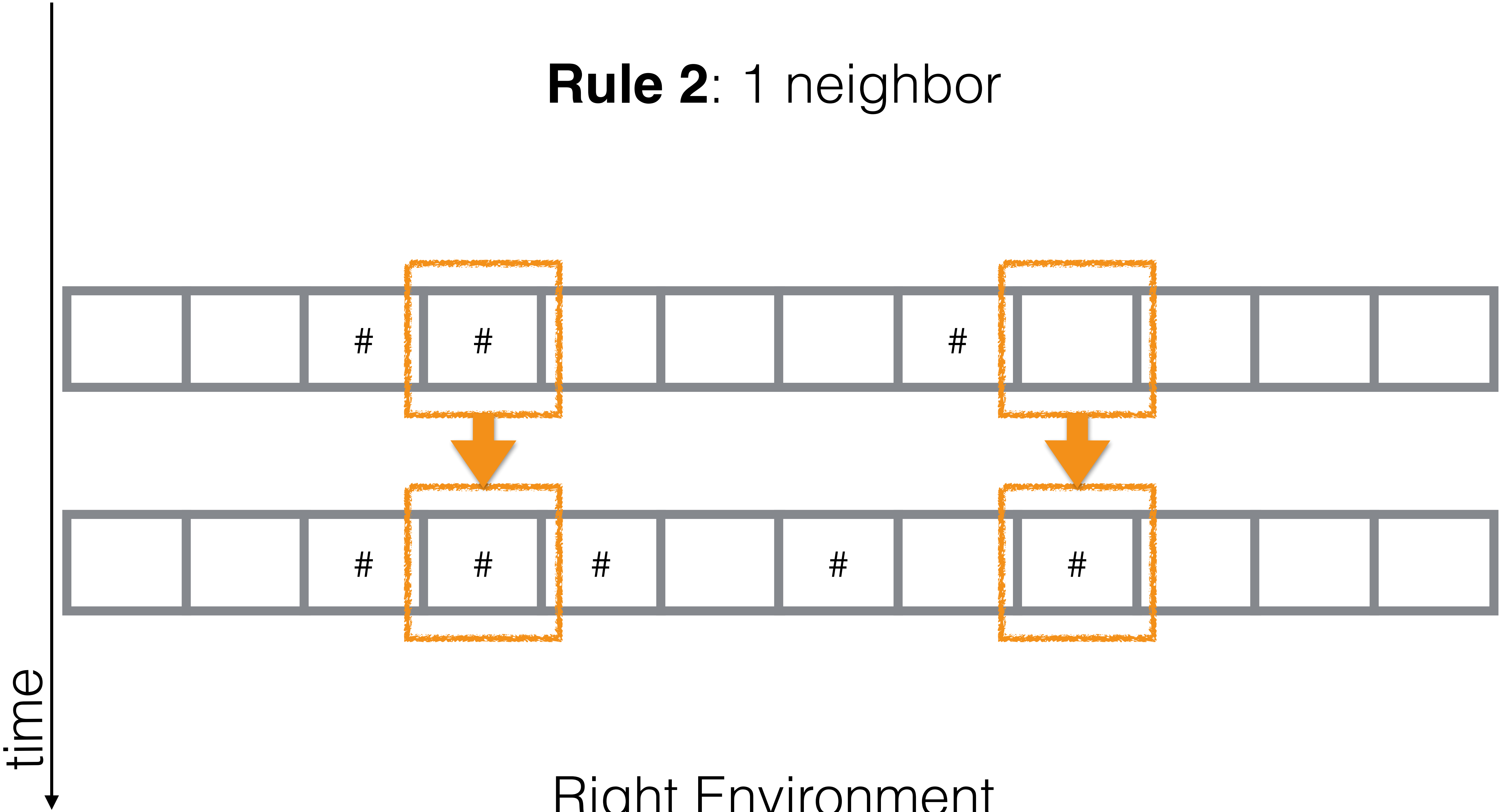
Rules of 1D-Life

Rule 2: 1 neighbor



Rules of 1D-Life

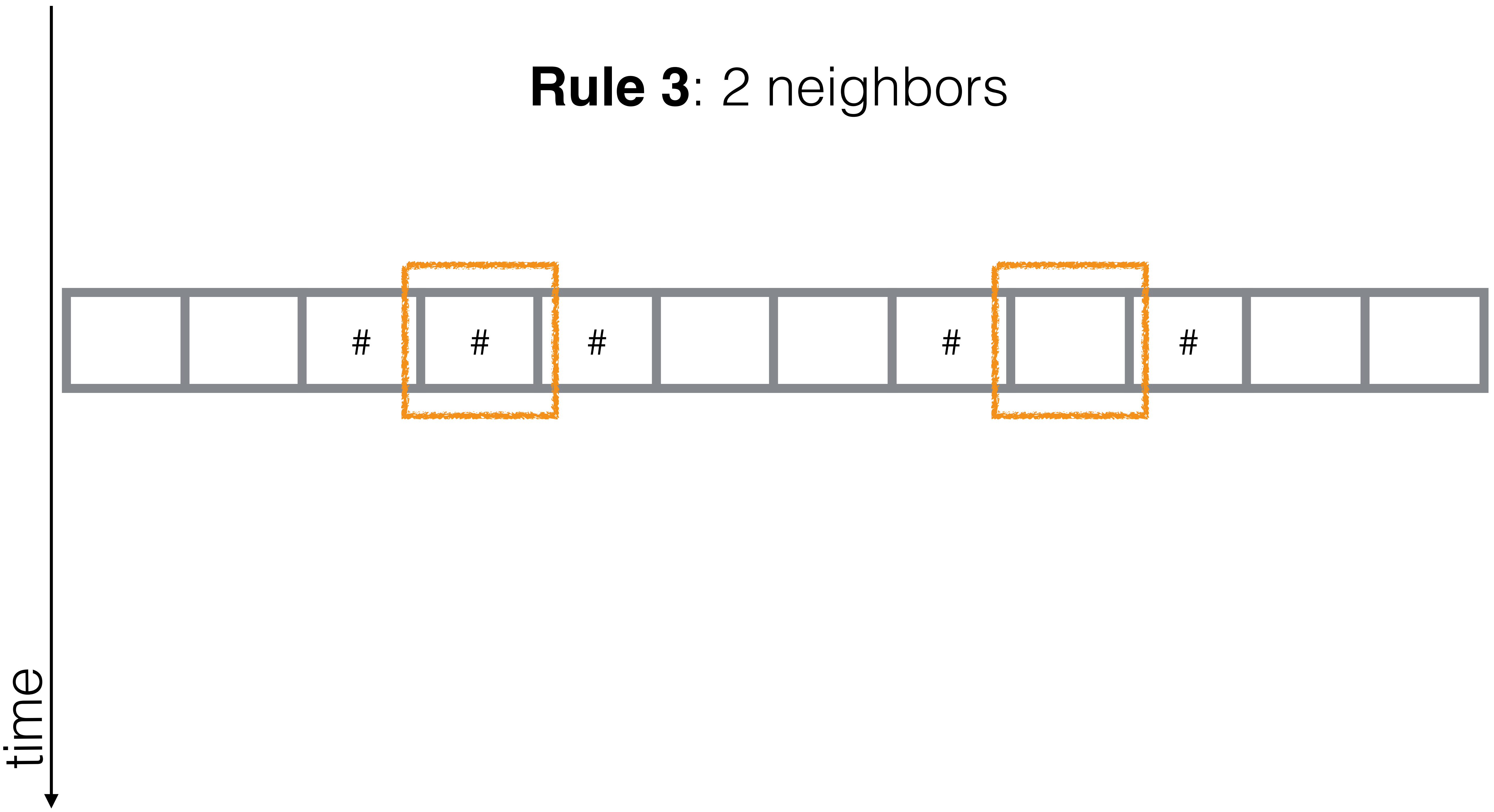
Rule 2: 1 neighbor



Right Environment

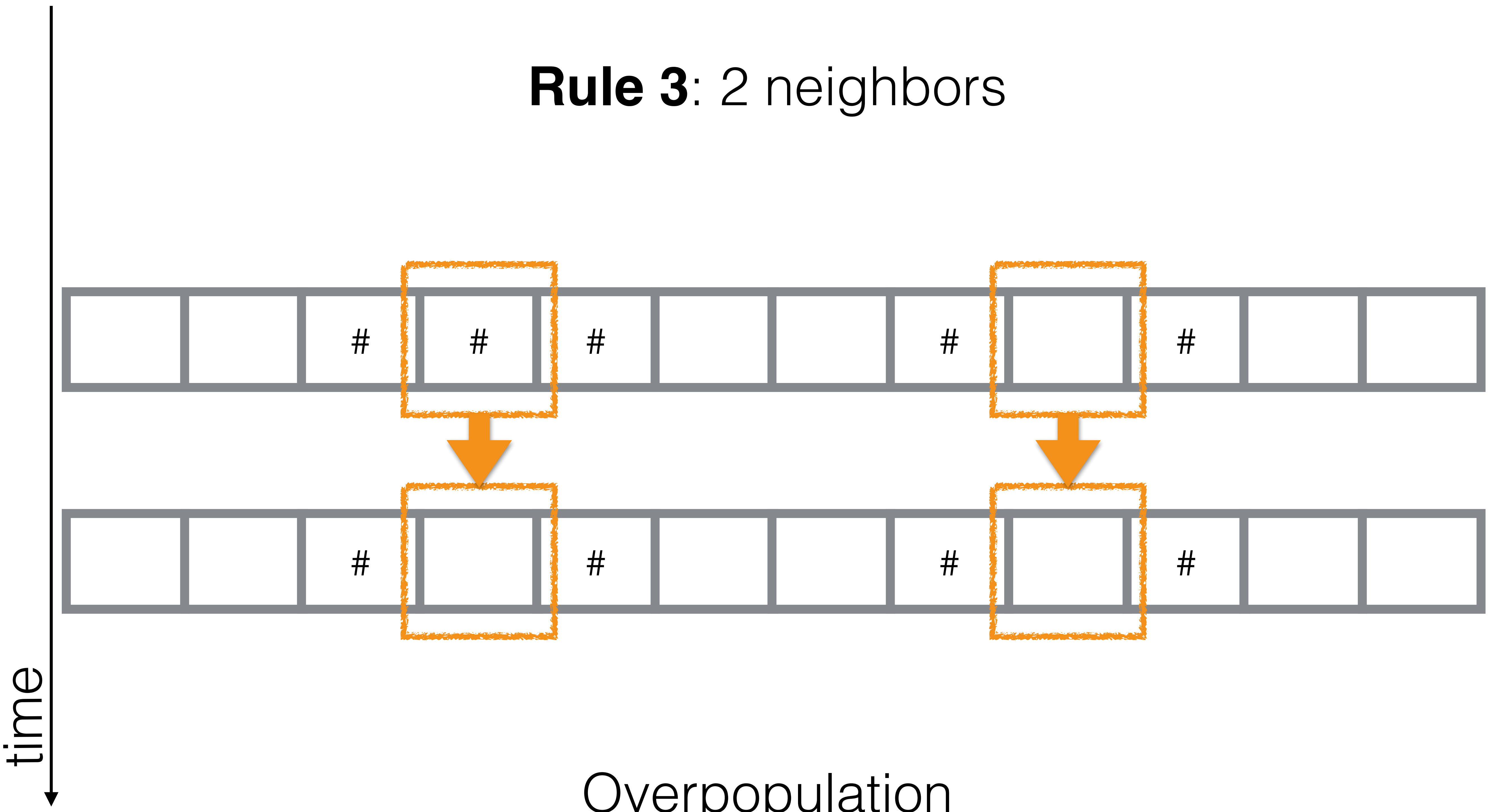
Rules of 1D-Life

Rule 3: 2 neighbors



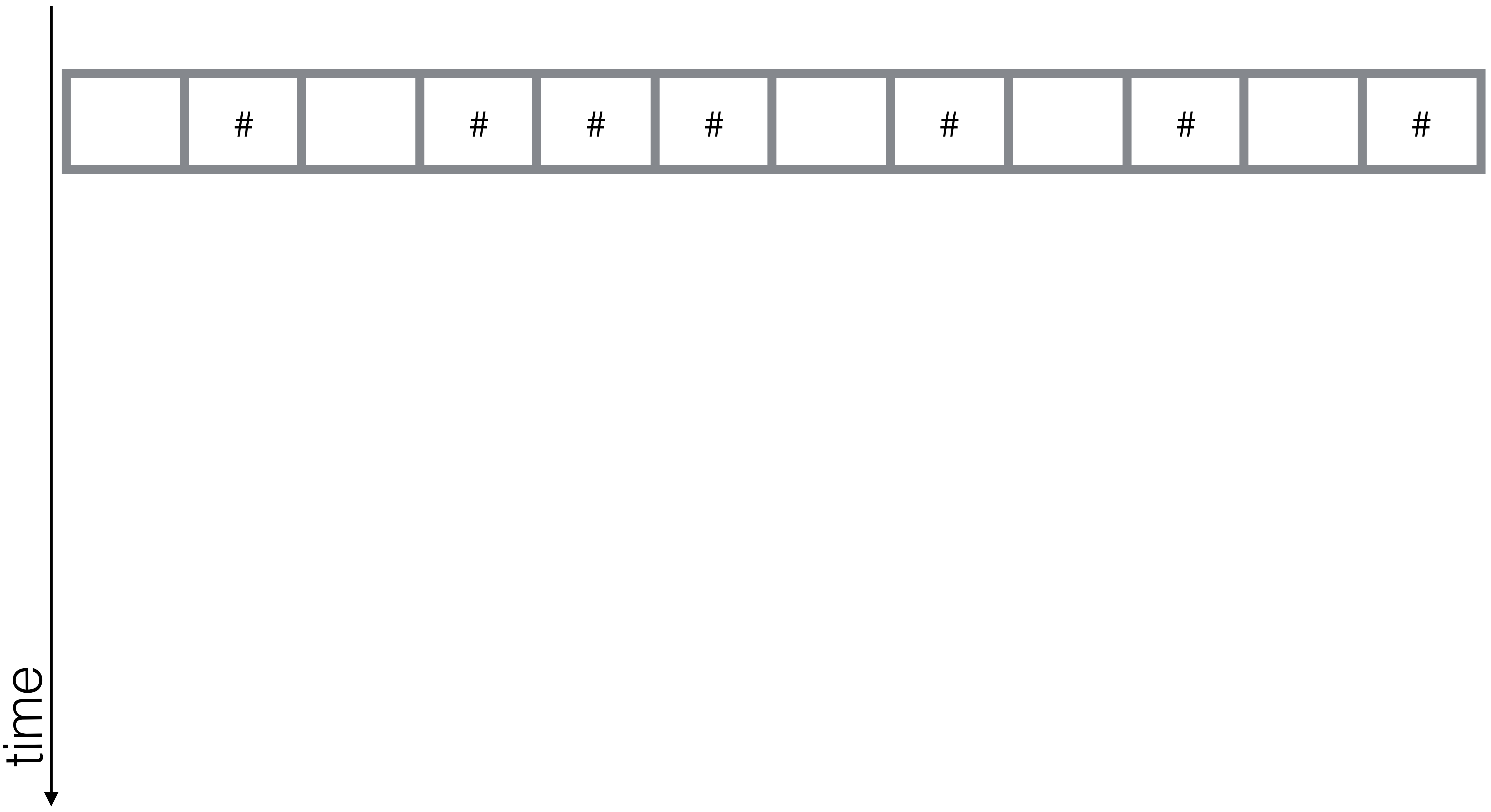
Rules of 1D-Life

Rule 3: 2 neighbors

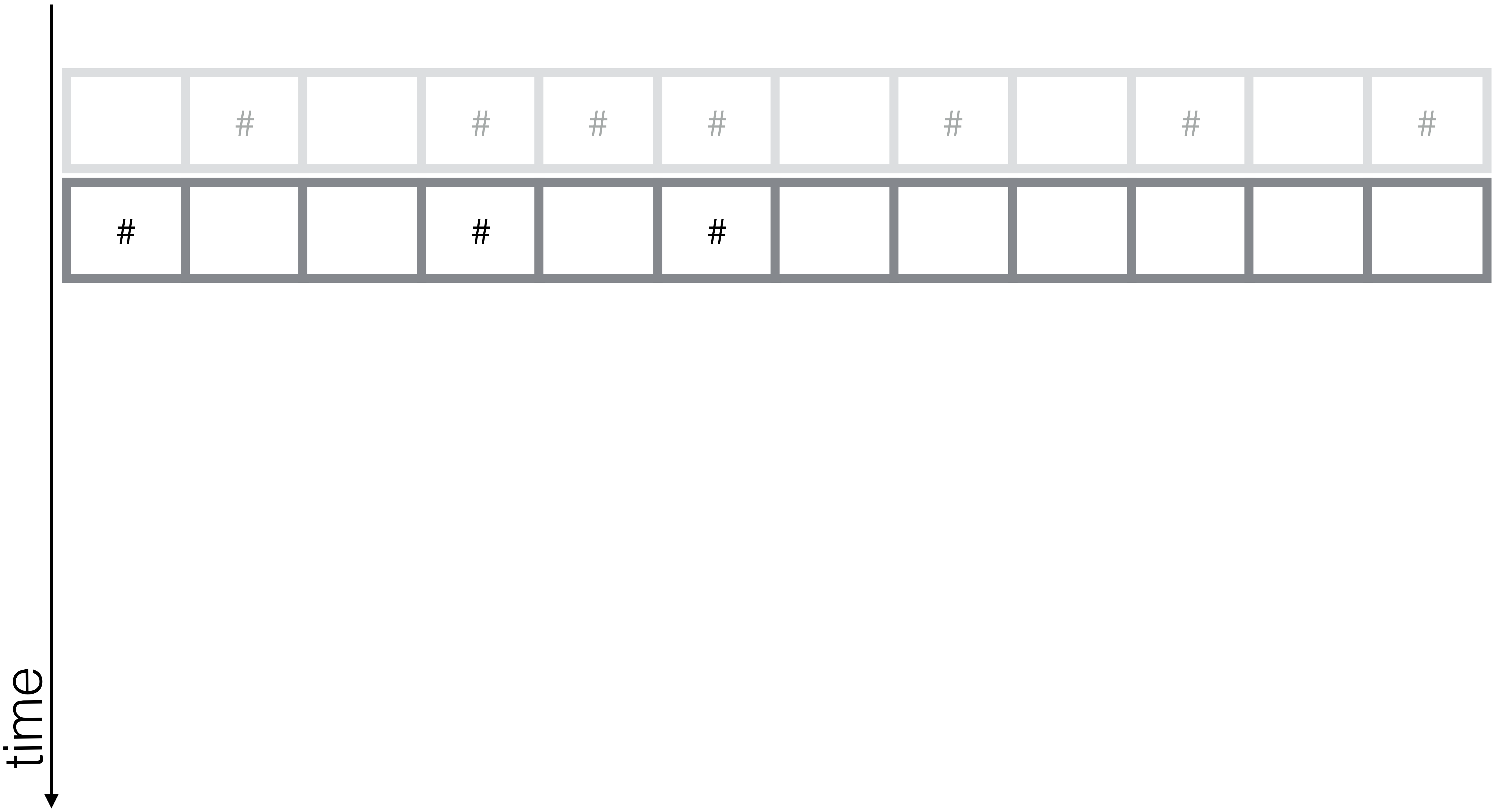


Overpopulation

Example

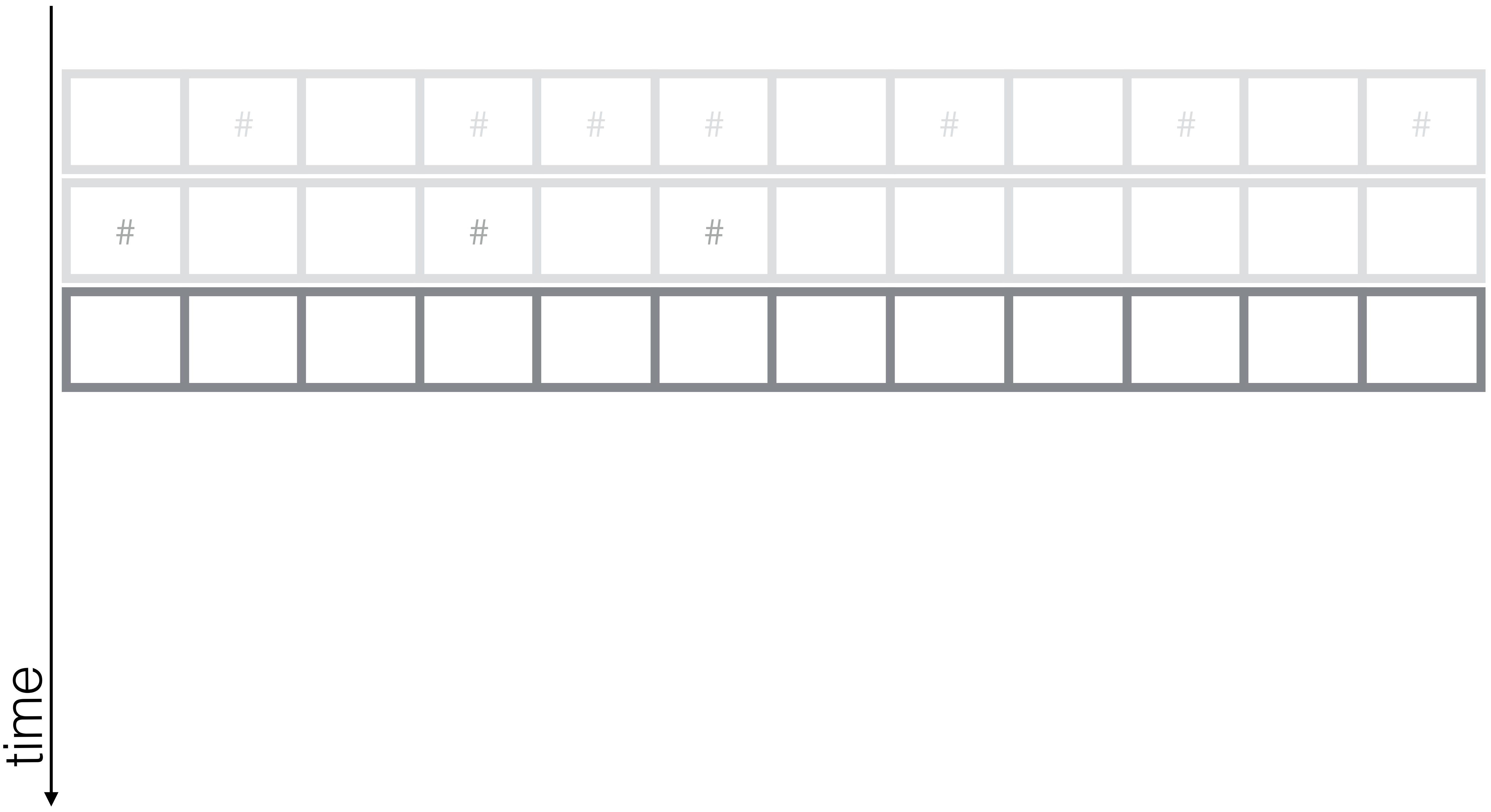


A 1-D Version

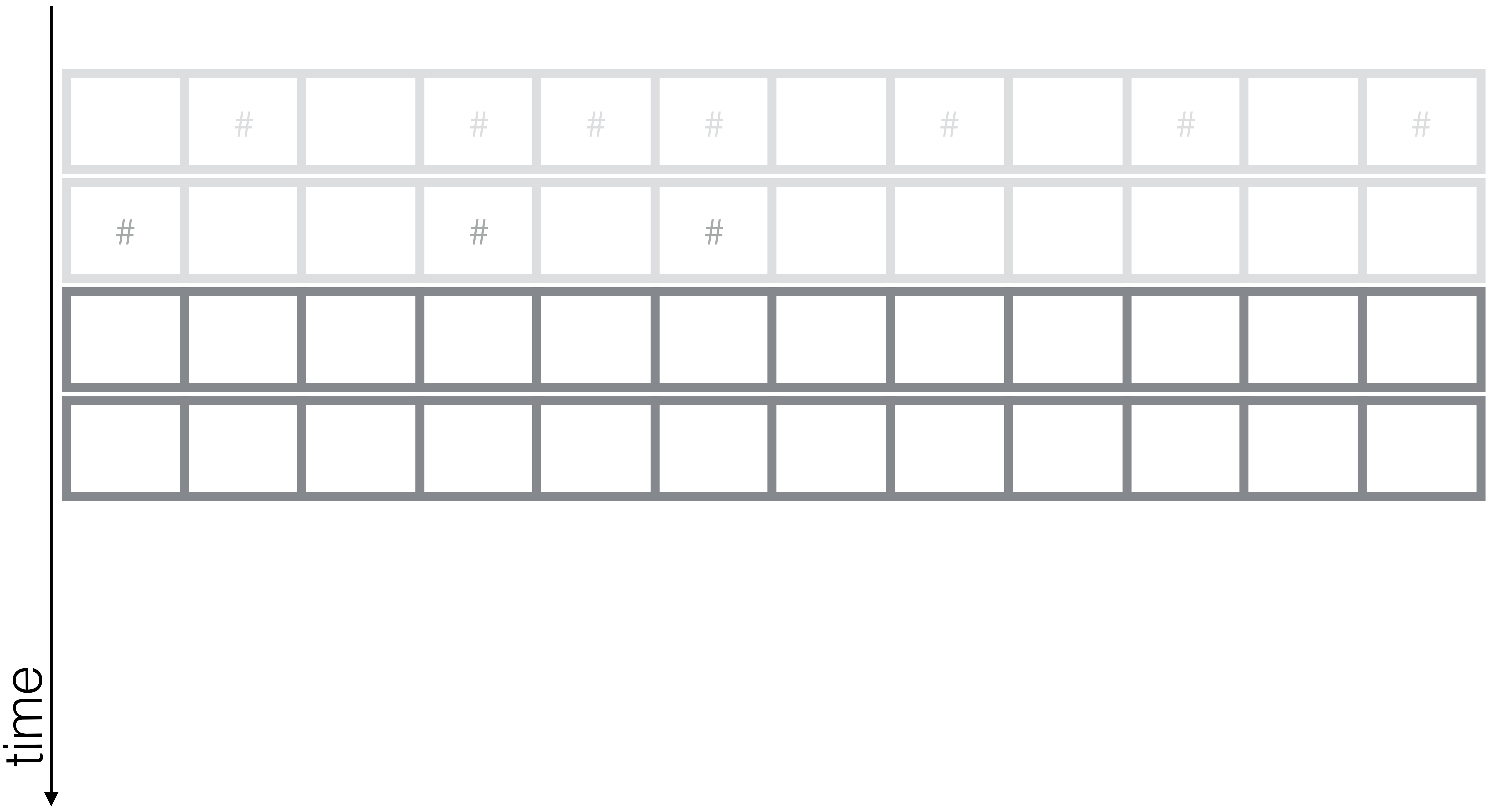


	#		#	#	#		#		#		#
#			#		#						

A 1-D Version



A 1-D Version

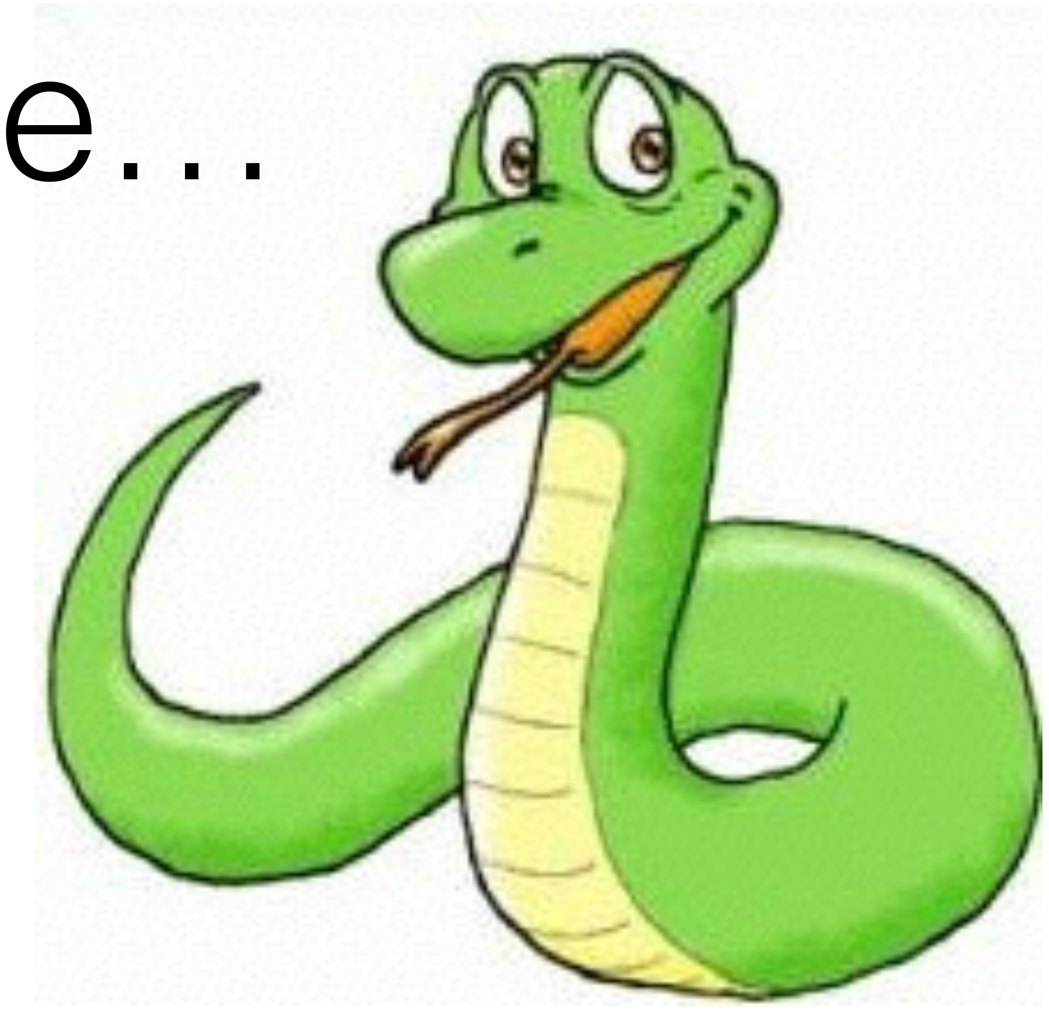


Problem of the Day(s):
Implement 1D Game of Life
in Assembly!

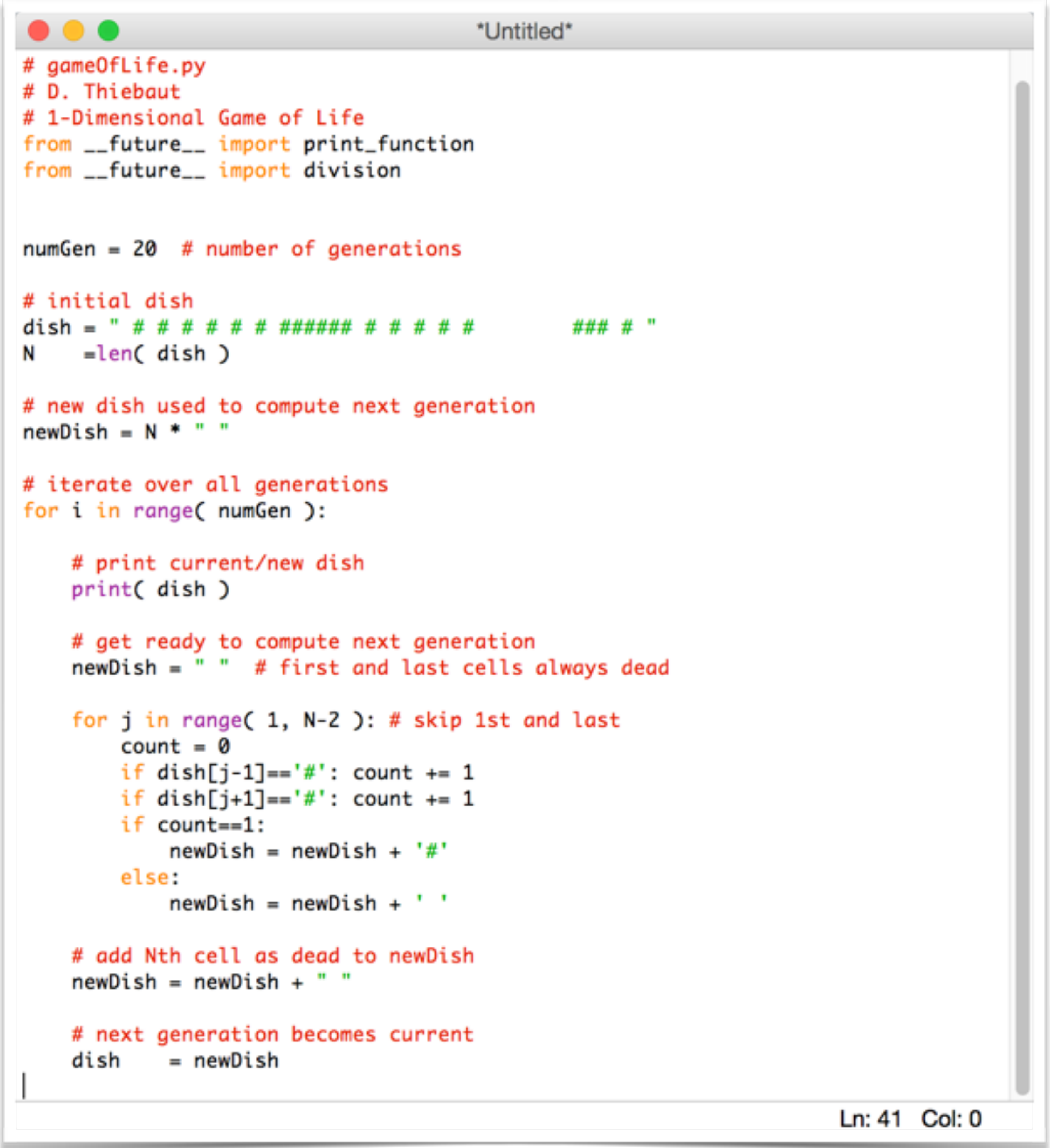
How to Approach This?

https://img.clipartfest.com/db77689f2cfc577629ec3ff678465323_managed-it-services-nj-it-person-with-question-mark-clipart_4100-6000.jpeg

#Step 1: Write Algorithm in an more "comfortable" language…



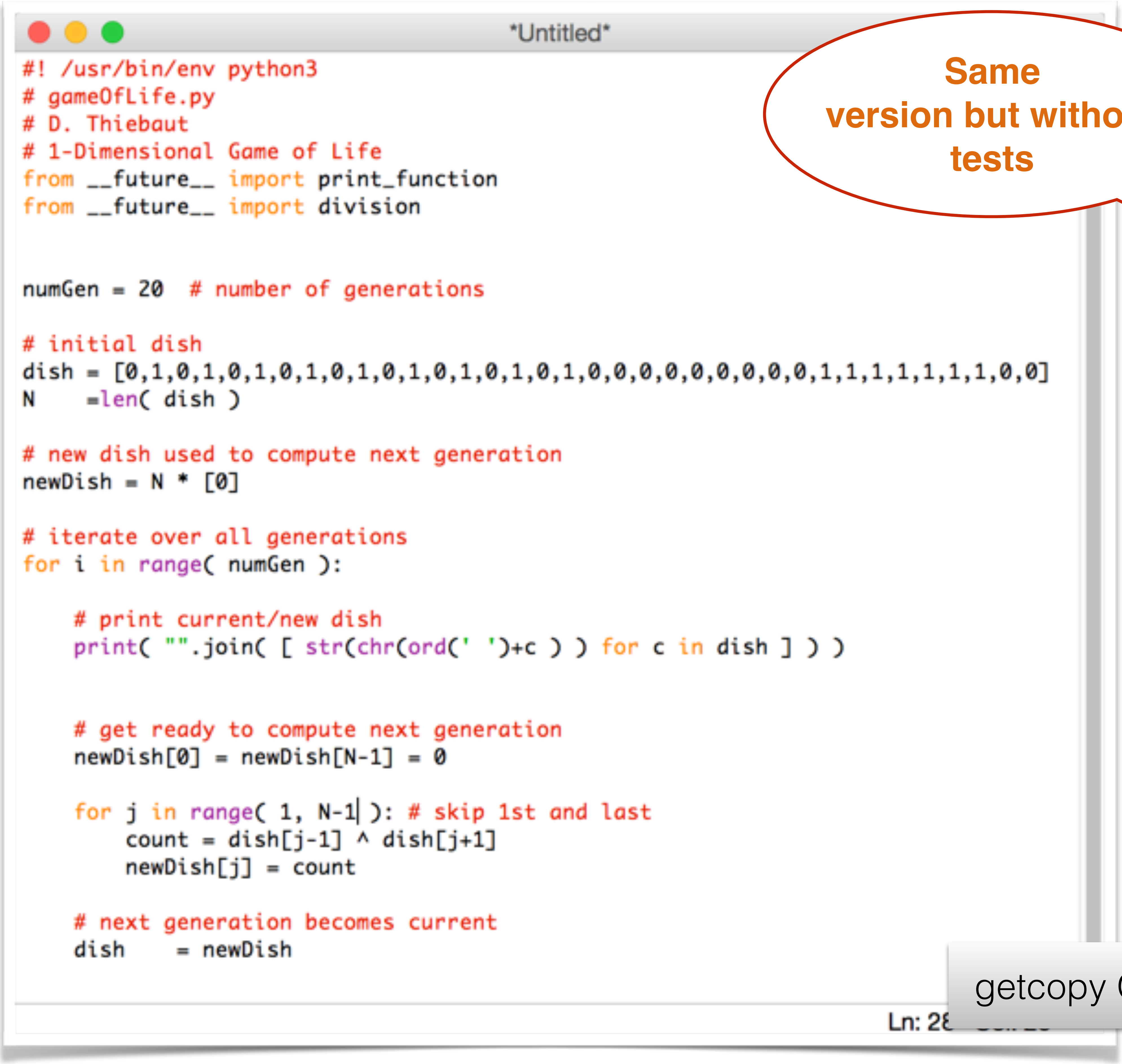
Game of Life
Python: V1



```
# gameOfLife.py
# D. Thiebaut
# 1-Dimensional Game of Life
from __future__ import print_function
from __future__ import division


numGen = 20  # number of generations

# initial dish
dish = " # # # # # # ###### # # # # #        ### # "
N    =len( dish )

# new dish used to compute next generation
newDish = N * " "

# iterate over all generations
for i in range( numGen ):

    # print current/new dish
    print( dish )

    # get ready to compute next generation
    newDish = " "  # first and last cells always dead

    for j in range( 1, N-2 ): # skip 1st and last
        count = 0
        if dish[j-1]=='#': count += 1
        if dish[j+1]=='#': count += 1
        if count==1:
            newDish = newDish + '#'
        else:
            newDish = newDish + ' '

    # add Nth cell as dead to newDish
    newDish = newDish + " "

    # next generation becomes current
    dish    = newDish
```

getcopy GameOfLife1D.py

Game of Life Python: V2

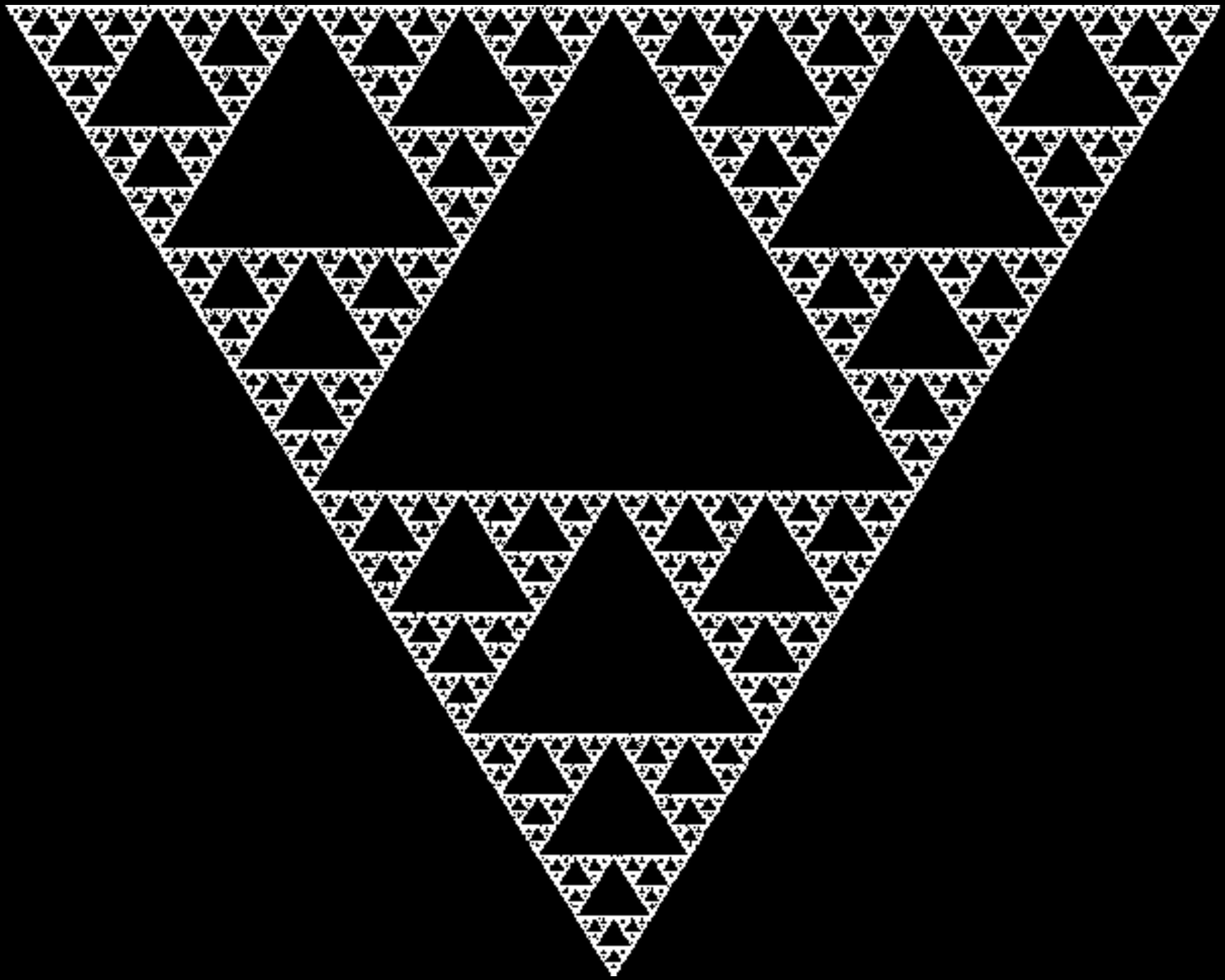


```
#! /usr/bin/env python3
# gameOfLife.py
# D. Thiebaut
# 1-Dimensional Game of Life
from __future__ import print_function
from __future__ import division


numGen = 20  # number of generations

# initial dish
dish = [0,1,0,1,0,1,0,1,0,1,0,1,0,1,0,1,0,1,0,0,0,0,0,0,0,0,0,1,1,1,1,1,1,1,0,0]
N     =len( dish )

# new dish used to compute next generation
newDish = N * [0]

# iterate over all generations
for i in range( numGen ):

    # print current/new dish
    print( "".join( [ str(chr(ord(' ')+c ) ) for c in dish ] ) )


    # get ready to compute next generation
    newDish[0] = newDish[N-1] = 0

    for j in range( 1, N-1 ): # skip 1st and last
        count = dish[j-1] ^ dish[j+1]
        newDish[j] = count

    # next generation becomes current
    dish     = newDish
```

Same version but without tests

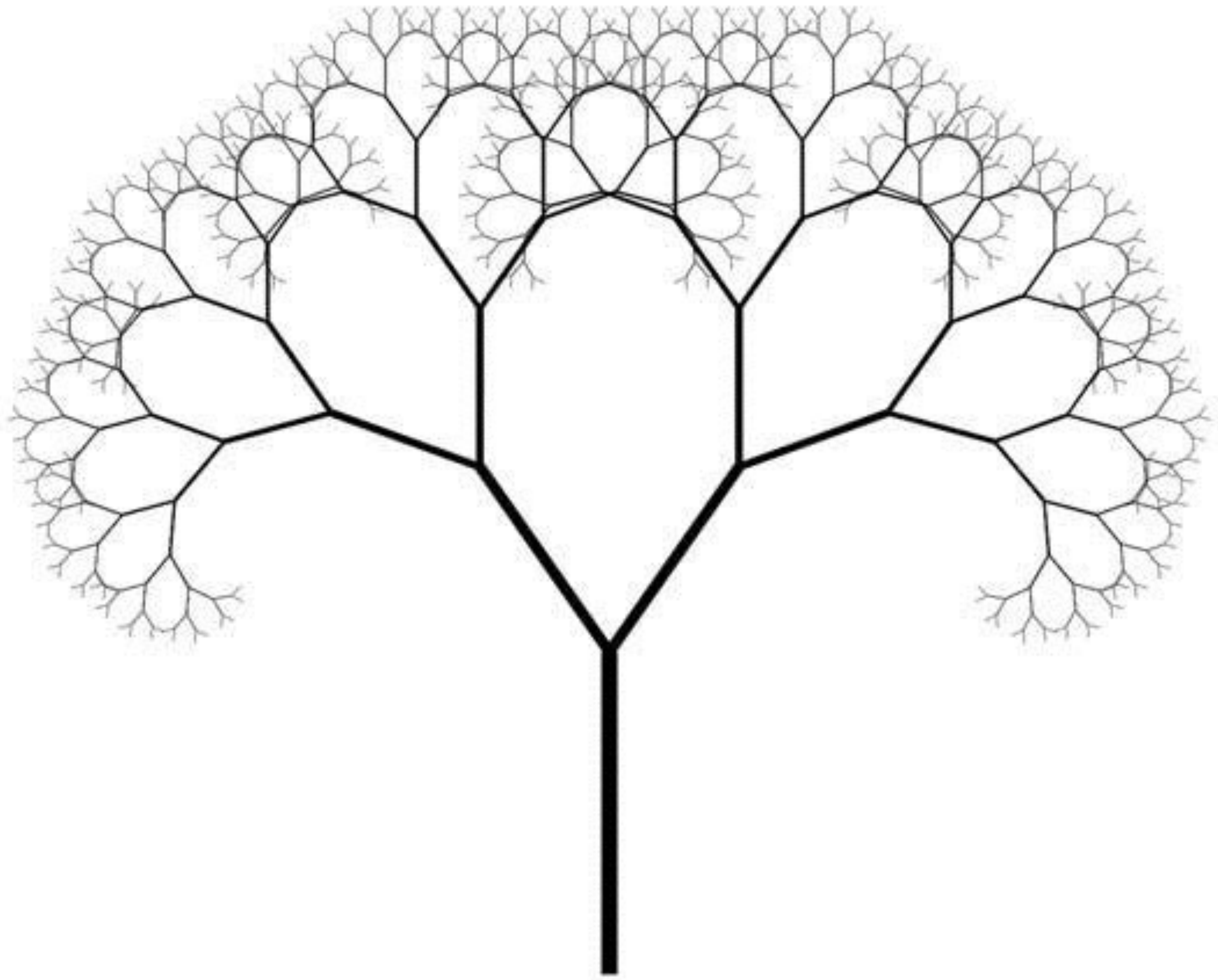
getcopy GameOfLife1D_V2.py

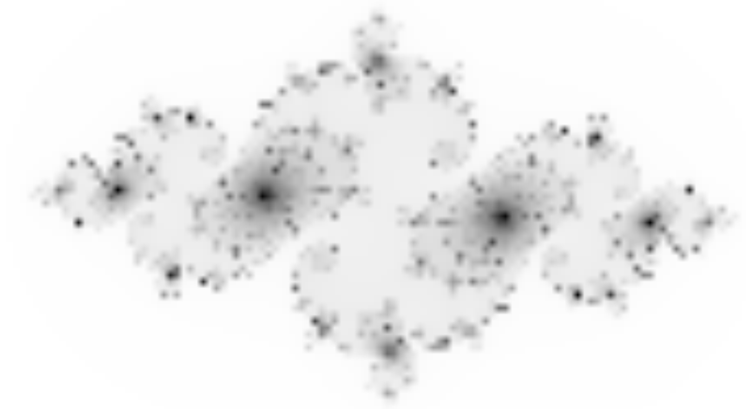
Sierpinski Gasket



http://www.lutanho.net/fractal/sierpa.html

Fractals





https://www.mnn.com/earth-matters/wilderness-resources/blogs/14-amazing-fractals-found-in-nature

Fractals

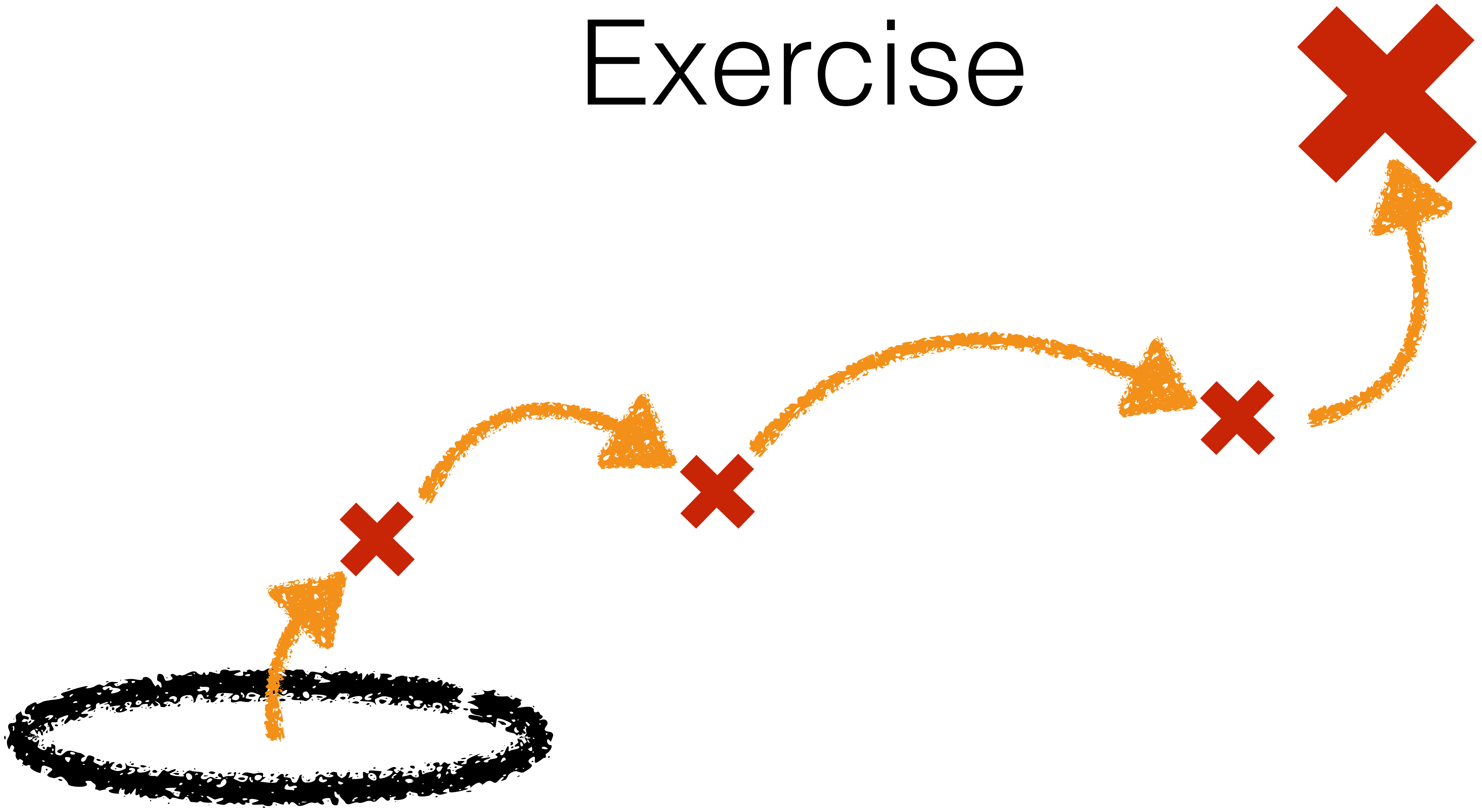
https://upload.wikimedia.org/wikipedia/commons/7/74/Dragon_trees.jpg

Review Homework #5

Back to Game of Life
Python to Assembly

- Develop Python solution
- Copy Python solution in assembly program and comment out all the lines
- Take groups of Python statements and translate into assembly
- Python program becomes natural comments for the assembly

Develop Assembly Program as a Class Exercise



If-statements in Assembly

Outline

- **Jmp**: the jump instruction
- **flags** register
- **conditional** jumps (jne, je, jgt, jge, jlt, jle, ja, jb…)

Jumping around…

```
 Start:
          mov       ebx, Table             ;
          jmp       there                  ;

 here:    mov       al, 1                  ;
          mov       ecx, N                 ;

 there:   mov       byte[ebx+esi], al      ;
          inc       esi                    ;
          add       al, al                 ;
          jmp       here                   ;
```

Jumping around…

```
_Start:
           mov      ebx, Table            ;
           jmp      there                 ;

here:      mov      al, 1                 ;
           mov      ecx, N                ;

there:     mov      byte[ebx+esi], al     ;
           inc      esi                   ;
           add      al, al                ;
           jmp      here                  ;
```

Jumping around…

```
_Start:
         mov      ebx, Table            ;
         jmp      there                 ;

here:    mov      al, 1                 ;
         mov      ecx, N                ;

there:   mov      byte[ebx+esi], al     ;
         inc      esi                   ;
         add      al, al                ;
         jmp      here                  ;
```

Jumping around...

```
_Start:
        mov     ebx, Table          ;
        jmp     there               ;

here:   mov     al, 1               ;
        mov     ecx, N              ;

there:  mov     byte[ebx+esi], al   ;
        inc     esi                 ;
        add     al, al              ;
        jmp     here                ;
```

Jumping around…

```
_Start:
        mov     ebx, Table          ;
        jmp     there               ;

here:   mov     al, 1               ;
        mov     ecx, N              ;

there:  mov     byte[ebx+esi], al   ;
        inc     esi                 ;
        add     al, al              ;
        jmp     here                ;
```

Jumping around…

```
_Start:
        mov     ebx, Table          ;
        jmp     there               ;

here:   mov     al, 1               ;
        mov     ecx, N              ;

there:  mov     byte[ebx+esi], al   ;
        inc     esi                 ;
        add     al, al              ;
        jmp     here                ;
```

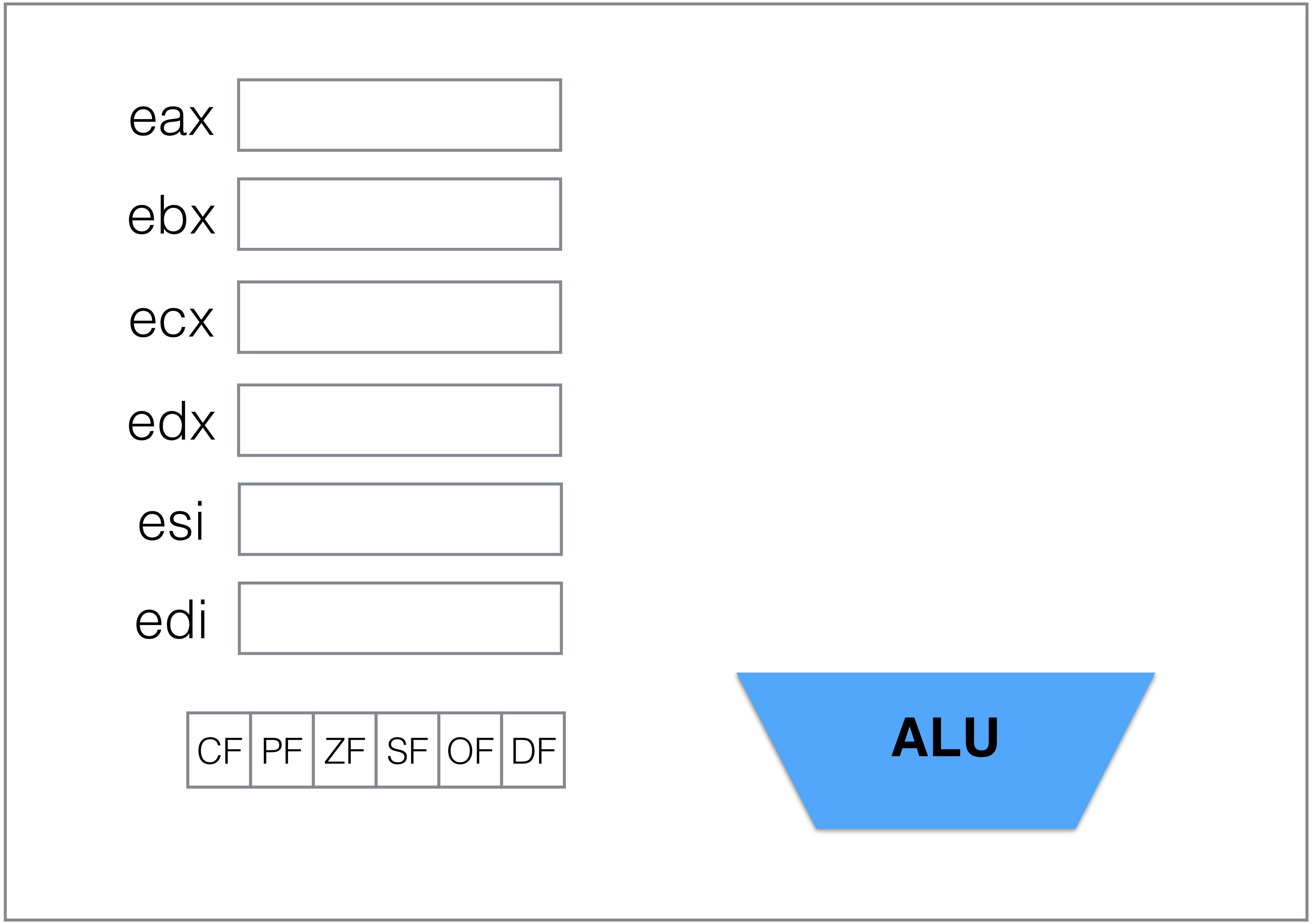
Jumping around…

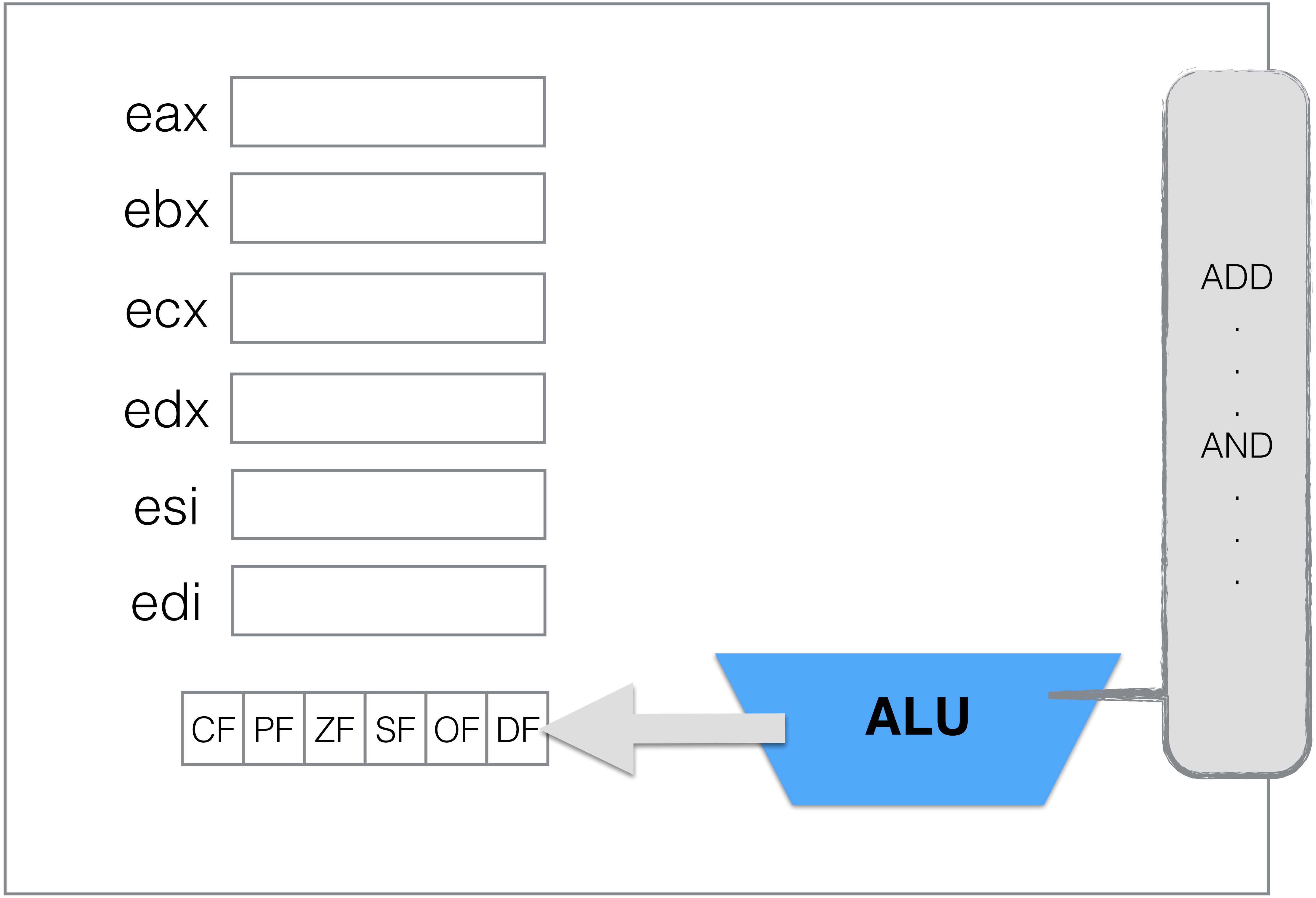
```
_Start:
        mov     ebx, Table          ;
        jmp     there               ;

here:   mov     al, 1               ;
        mov     ecx, N              ;

there:  mov     byte[ebx+esi], al   ;
        inc     esi                 ;
        add     al, al              ;
        jmp     here                ;
```

Jumping around…

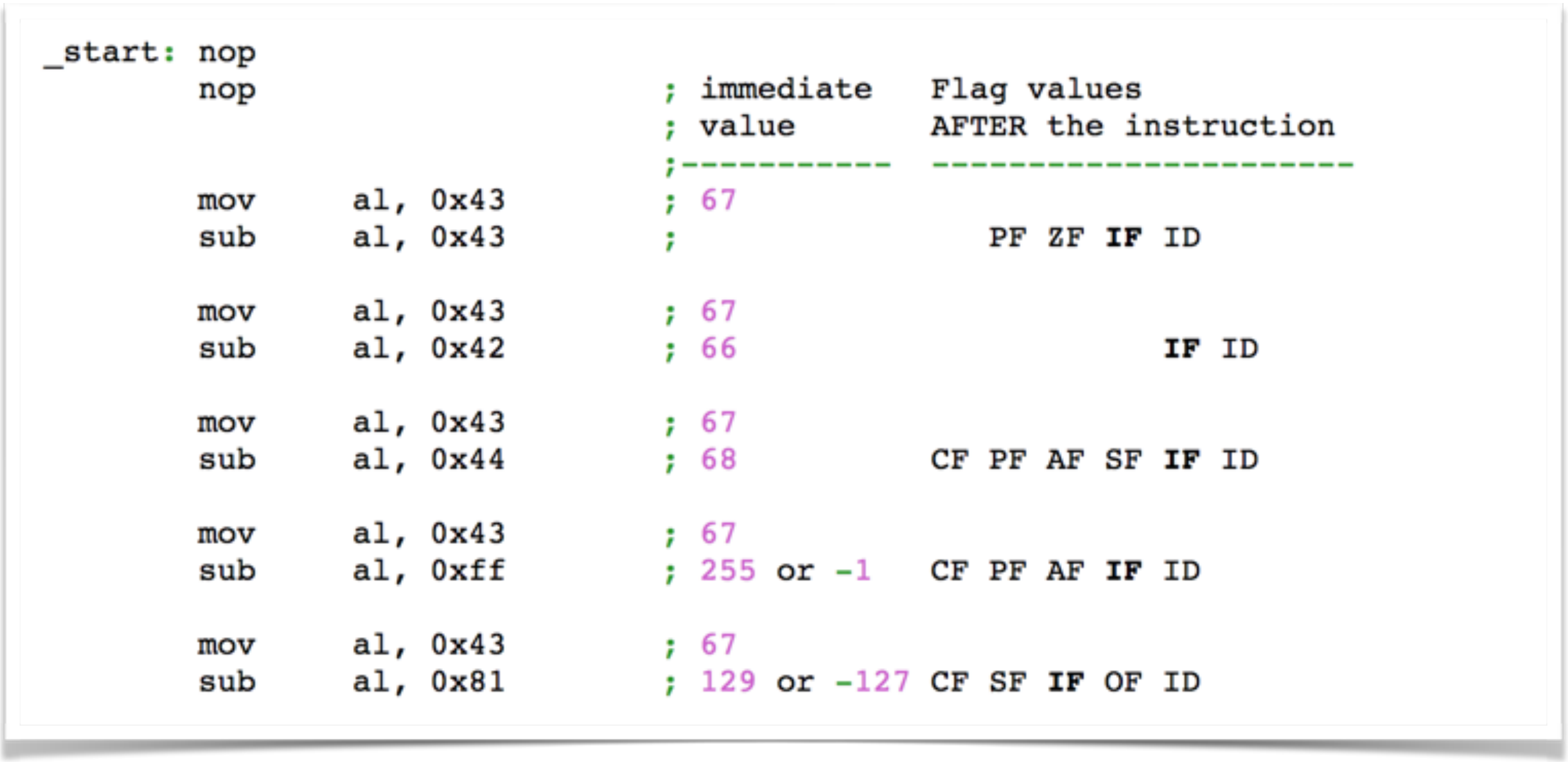
```
_Start:
        mov     ebx, Table            ;
        jmp     there                 ;

here:   mov     al, 1                 ;
        mov     ecx, N                ;

there:  mov     byte[ebx+esi], al     ;
        inc     esi                   ;
        add     al, al                ;
        jmp     here                  ;
jmp there          ;"mov eip,there"
```

Flags Register


eax
ebx
ecx
edx
esi
edi
CF
PF
ZF
SF
OF
DF
ALU


eax
ebx
ecx
edx
esi
edi
CF
PF
ZF
SF
OF
DF
ALU
ADD
.
.
.
AND
.
.
.

Examples



```
_start: nop
        nop                     ; immediate   Flag values
                                ; value       AFTER the instruction
                                ;-----------  ----------------------
        mov     al, 0x43        ; 67
        sub     al, 0x43        ;                PF ZF IF ID

        mov     al, 0x43        ; 67
        sub     al, 0x42        ; 66                      IF ID

        mov     al, 0x43        ; 67
        sub     al, 0x44        ; 68          CF PF AF SF IF ID

        mov     al, 0x43        ; 67
        sub     al, 0xff        ; 255 or -1   CF PF AF IF ID

        mov     al, 0x43        ; 67
        sub     al, 0x81        ; 129 or -127 CF SF IF OF ID
```

IDEA!

- We need an instruction that will jump to some place other than the next instruction if one or more of the flags bits are set a particular way
- For example, it would be great to see what flag bits are set when the result of a subtraction is positive or zero, and create a **special jump instruction that jumps to some label only if these bits are set**.

Meet the Conditional Jumps!

- je, jz
- jne, jnz
- jl
- jle
- jg
- jge

Meet the CMP instruction!

- **cmp op1, op2** ; op1 - op2, set the flag bits

We stopped here last time…

Examples

```
; if eax == ebx:
;    count += 1
;
```

```
; if dish[j] == 1:
;    dishString[j] = '#'
; else
;    dishString[j] = ' '
```

Examples

```
; # c is a char
; if c >= 'a' and c <= 'z':
;     c = chr( ord(c)-32 )
; …
```

Examples

```
; if x > 0xFFFFFFFF:
;     z = x+2
; else:
;     z = x-1
```

Meet the Conditional Jumps!

- je, jz
- jne, jnz
- jl
- jle
- jg
- jge

- je, jz
- jne, jnz
- jb
- jbe
- ja
- jae