

YOU ARE IN A MAZE OF TWISTY PASSAGES...

MINOS 2009

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WWW.MICROMOUSEONLINE.COM

FAST IS GOOD

- Exploration Penalty
- Non-stop Exploring
- Multiple Strategies

FAST IS GOOD

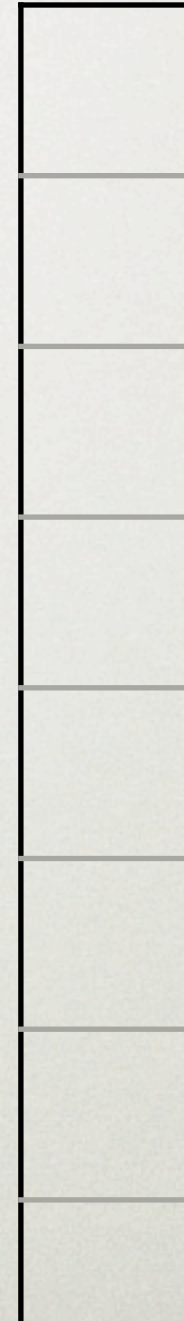
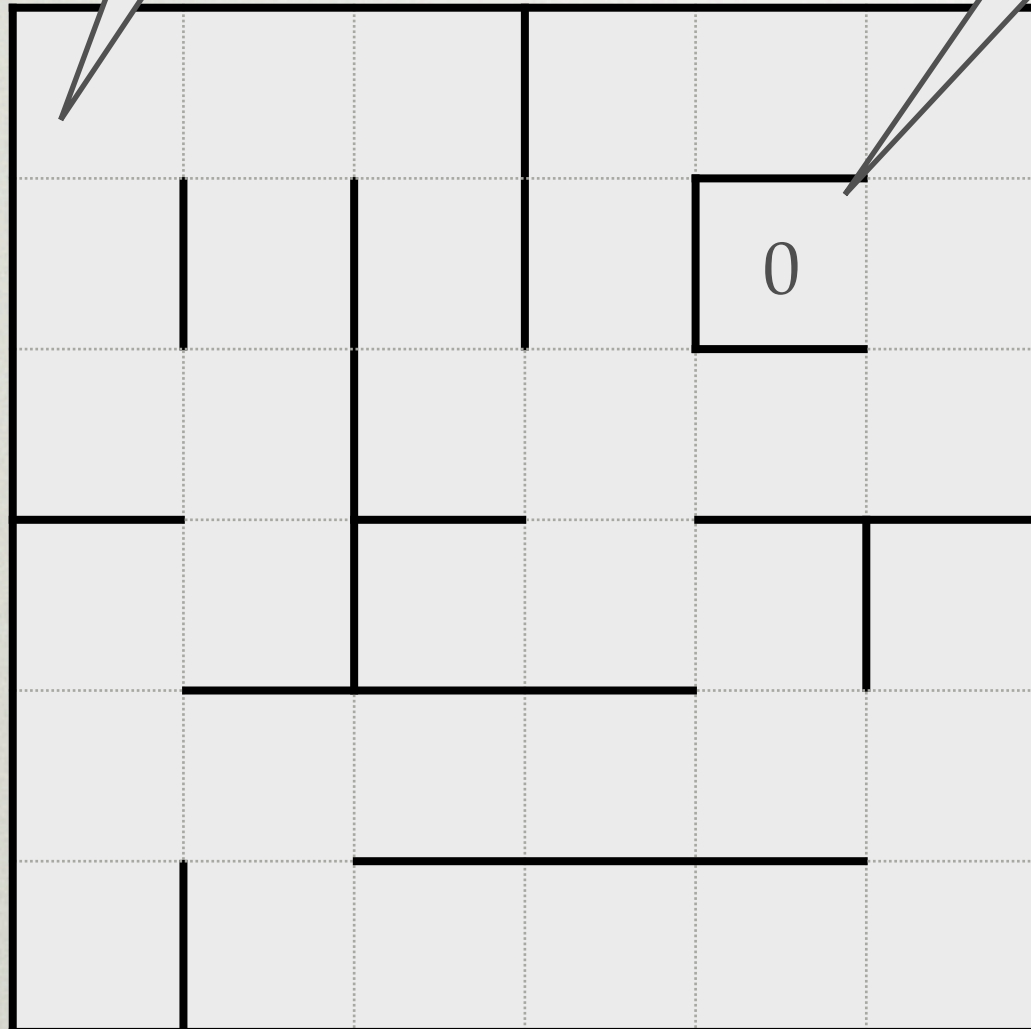
- Explore: $v = 0.5\text{ms}^{-1}$, $a = 1.5\text{ms}^{-2}$
- Braking distance $s_b = v^2 / 2a = 83\text{mm}$
- Decide on cell boundary
- Thinking distance = 7mm
- Thinking time = $s / v = 14\text{ms}$

AT THE START

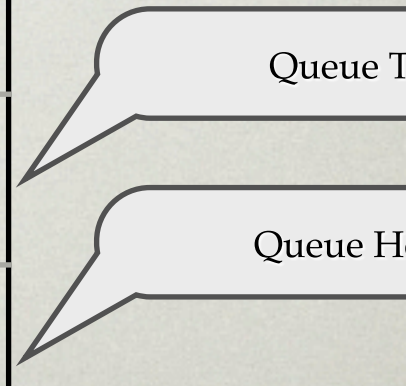
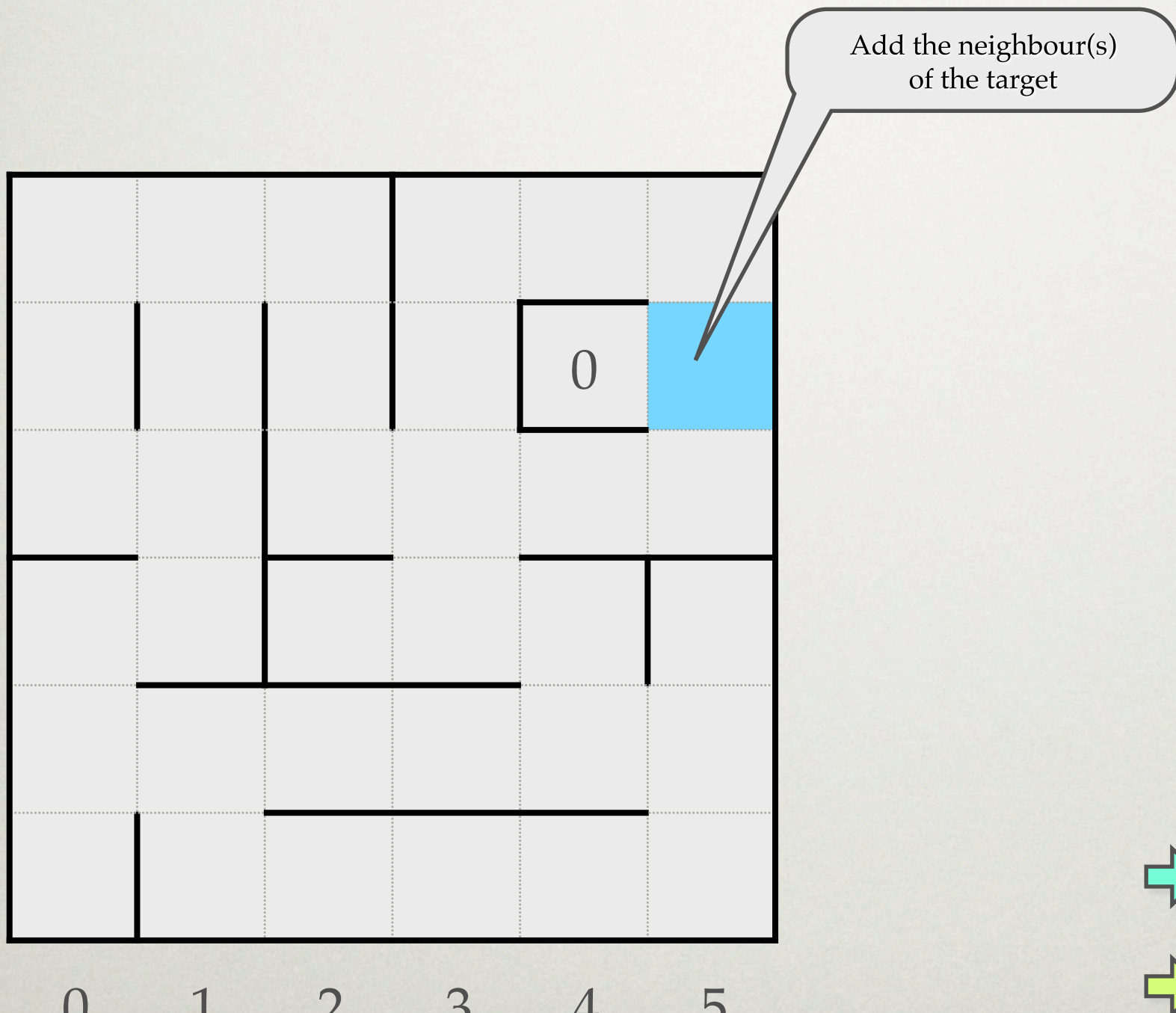
Seed the maze with 255

Seed the target with zeros

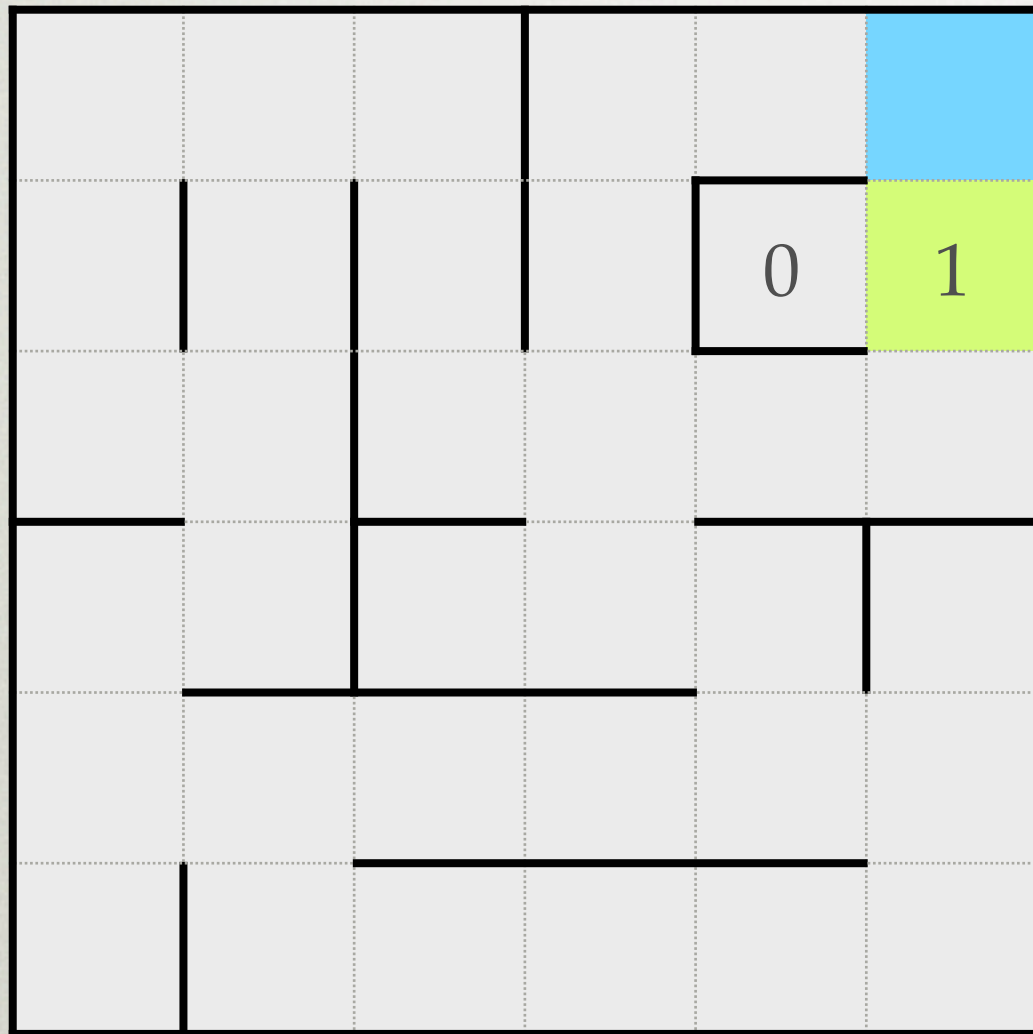
Create a queue



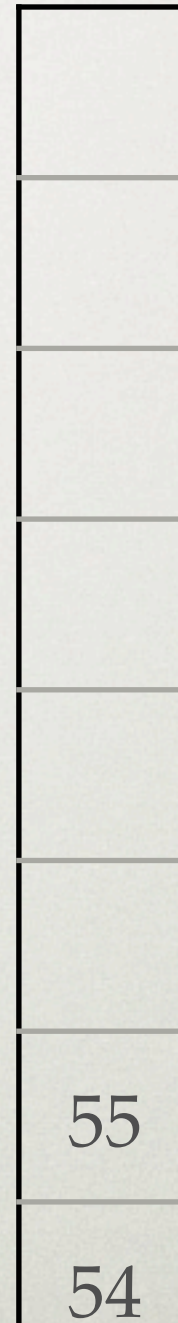
READY TO GO



ADD NEIGHBOURS

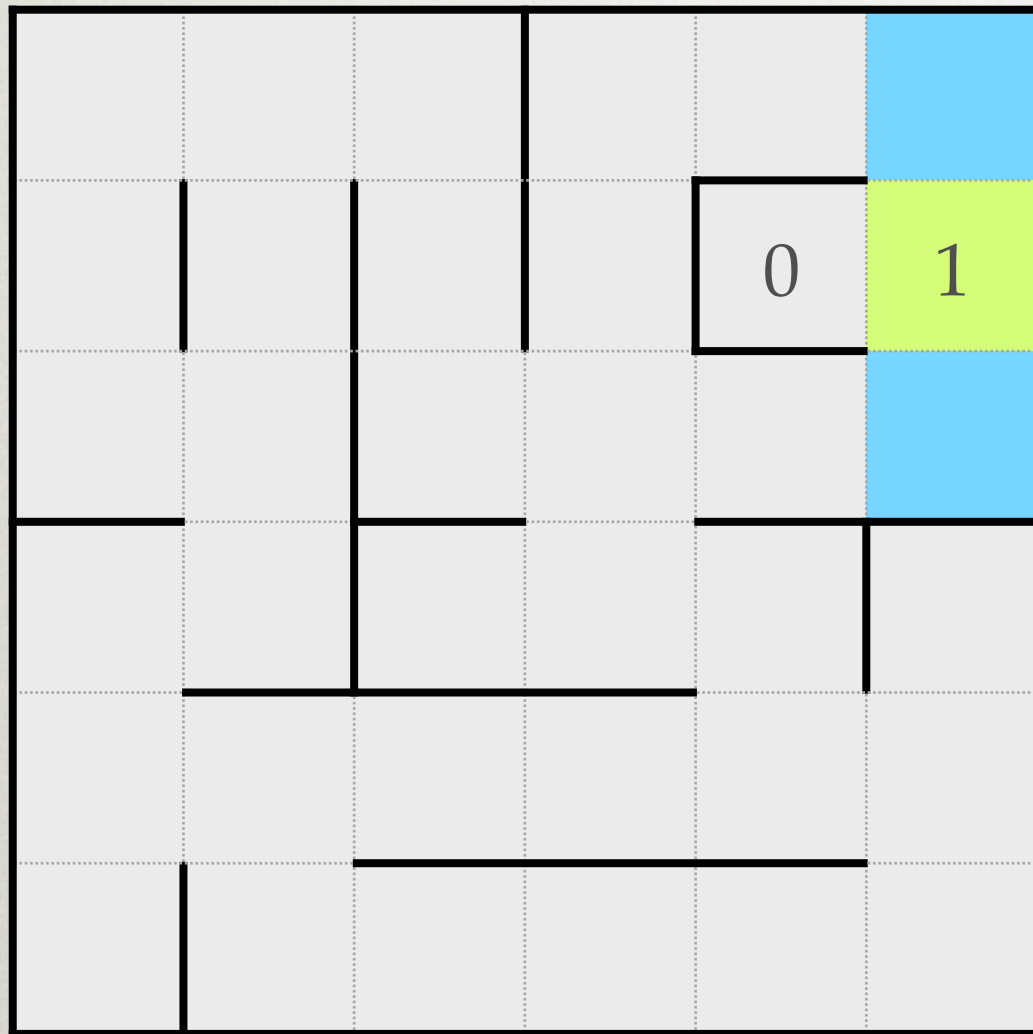


0 1 2 3 4 5



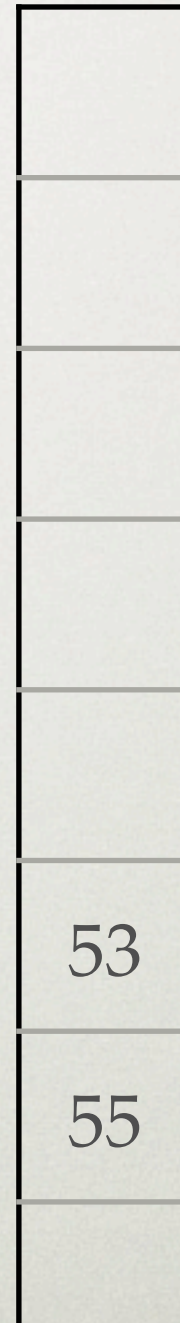
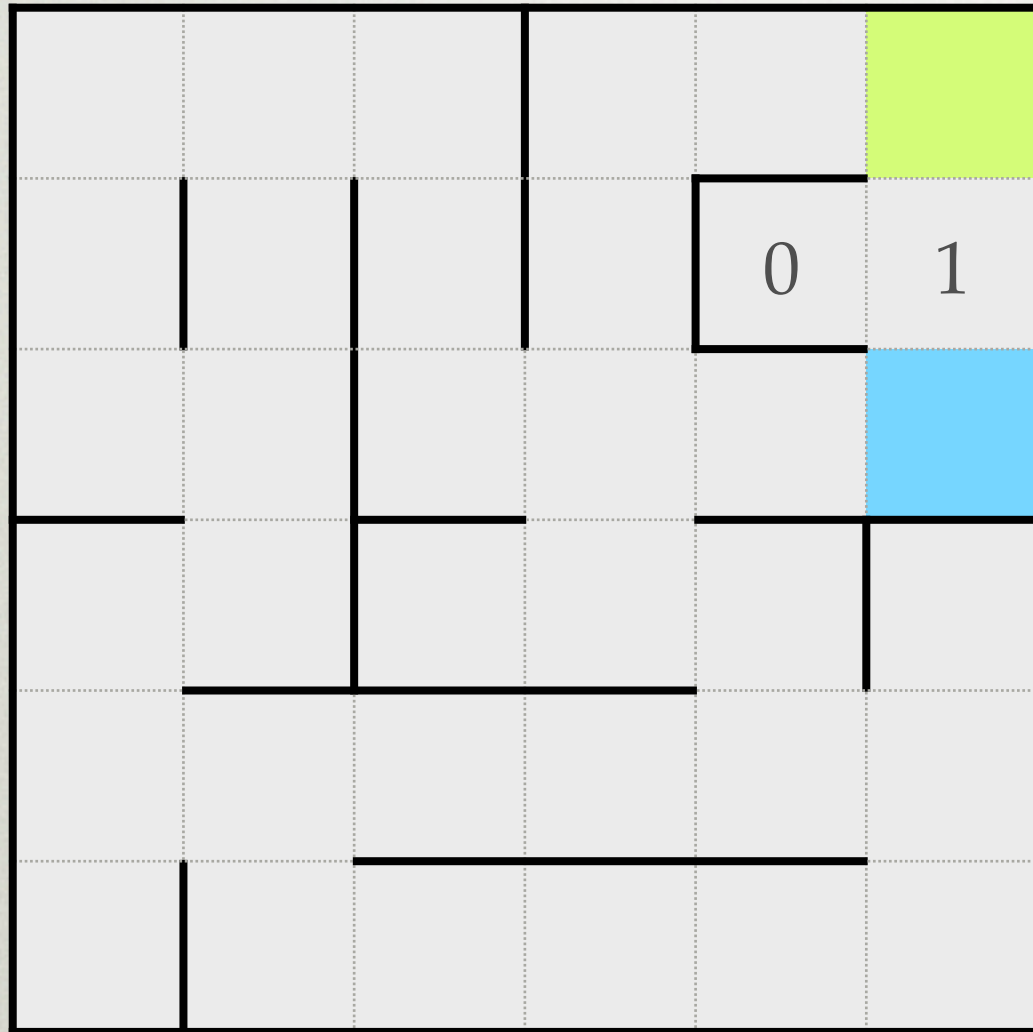
clockwise from 1

ADD NEIGHBOURS

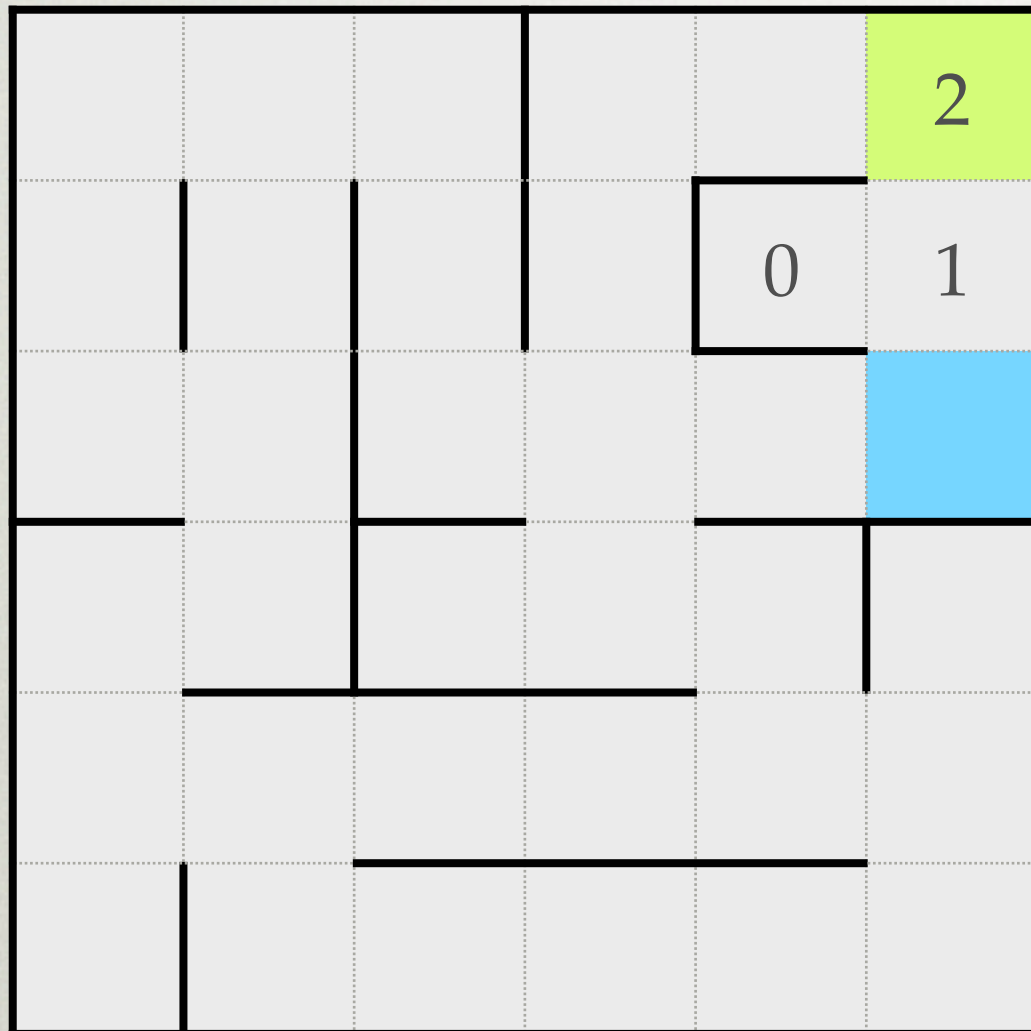


53
55
54

FINISHED PROCESSING

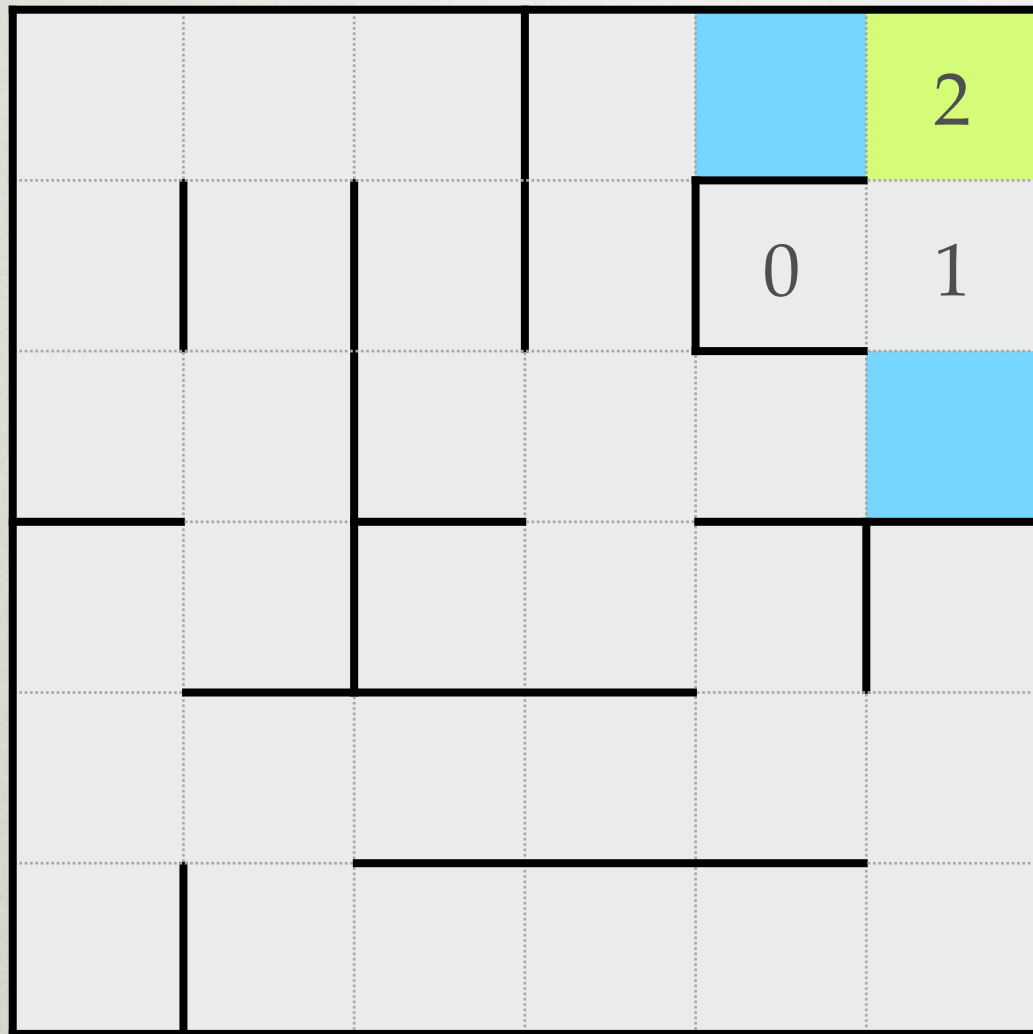


CALCULATE DISTANCE



53
55

ADD NEIGHBOURS



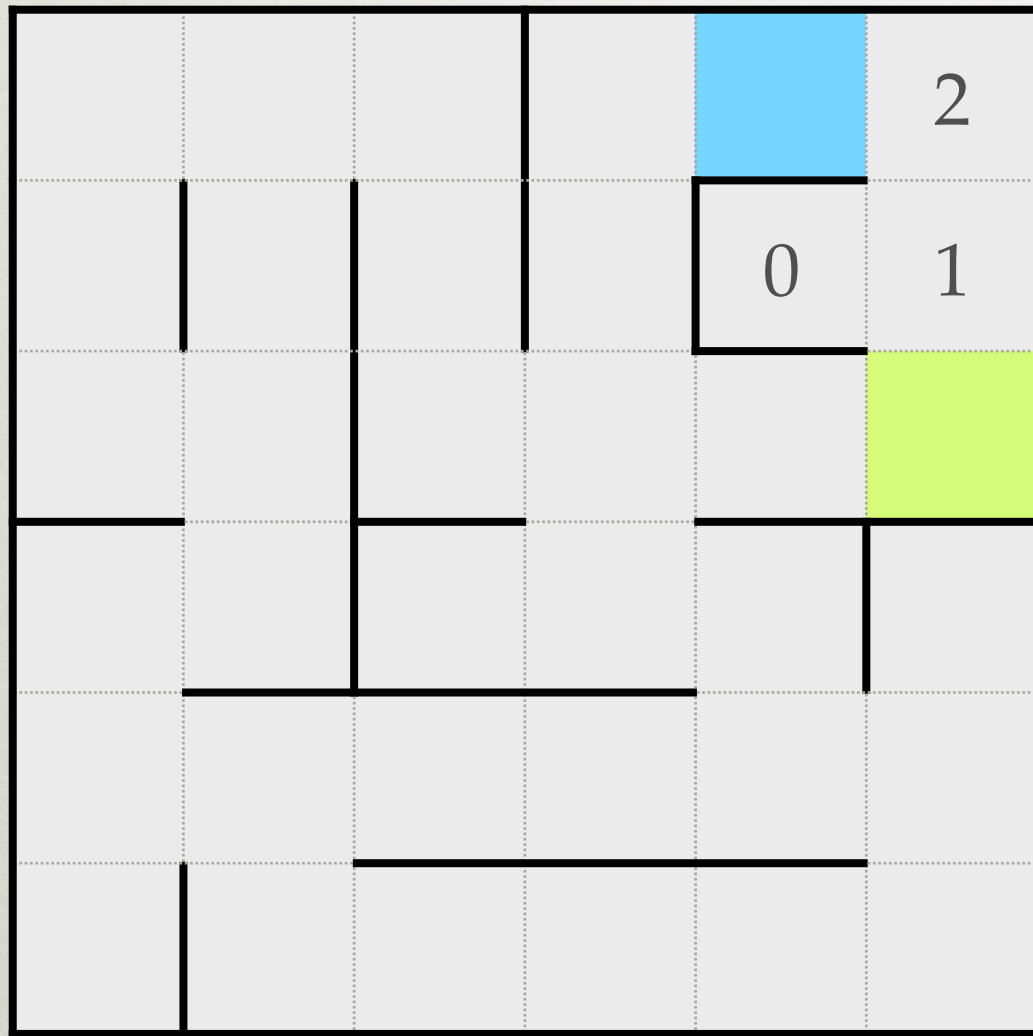
45

53

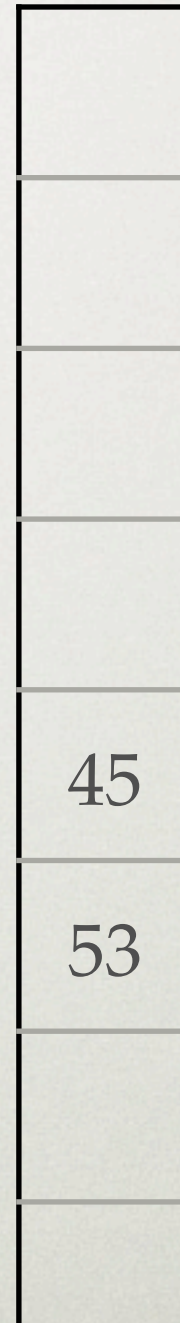
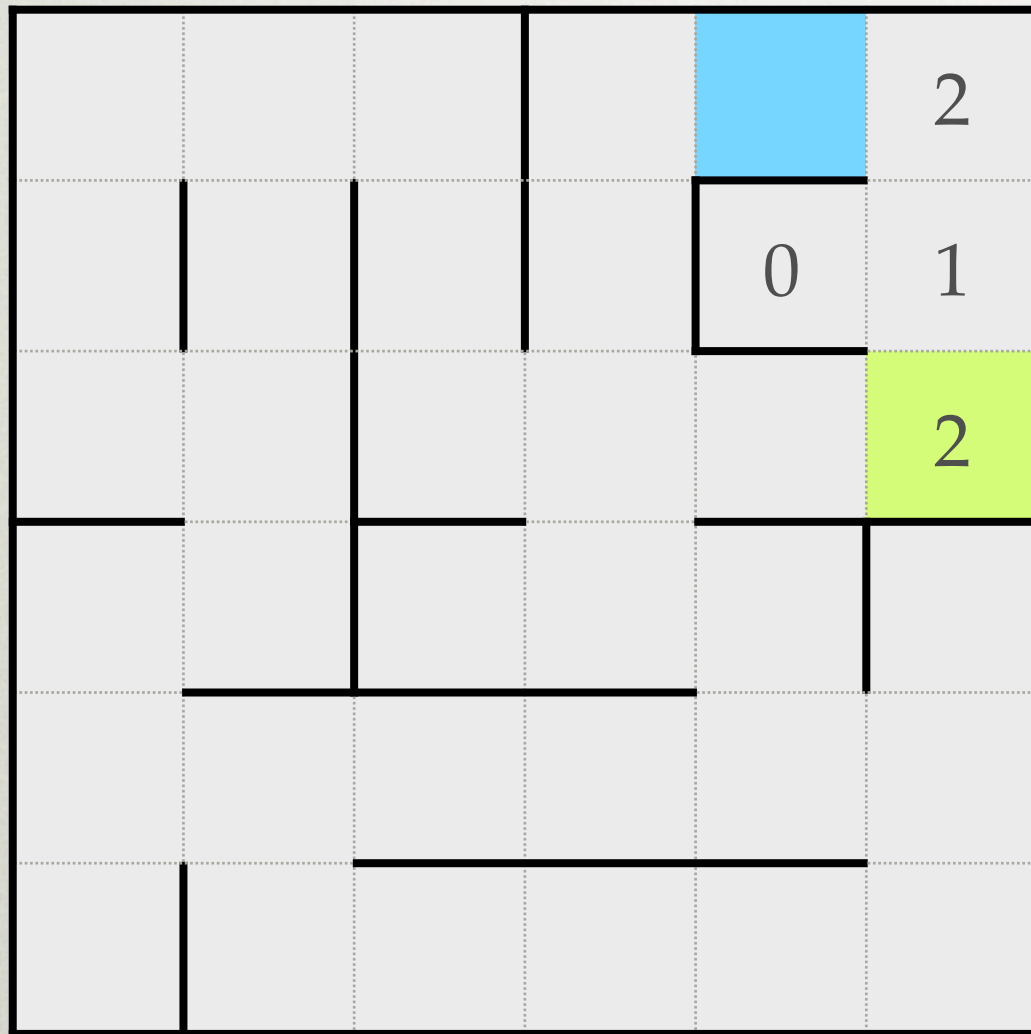


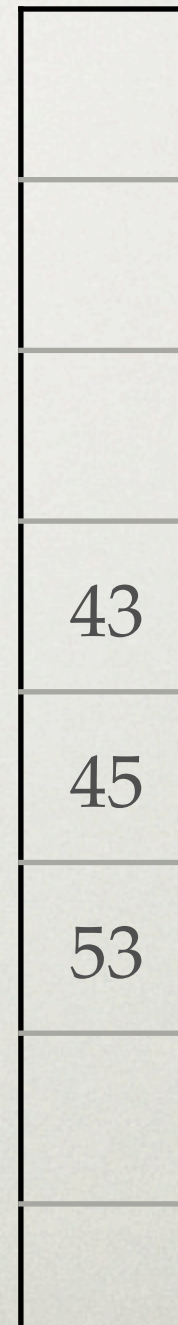
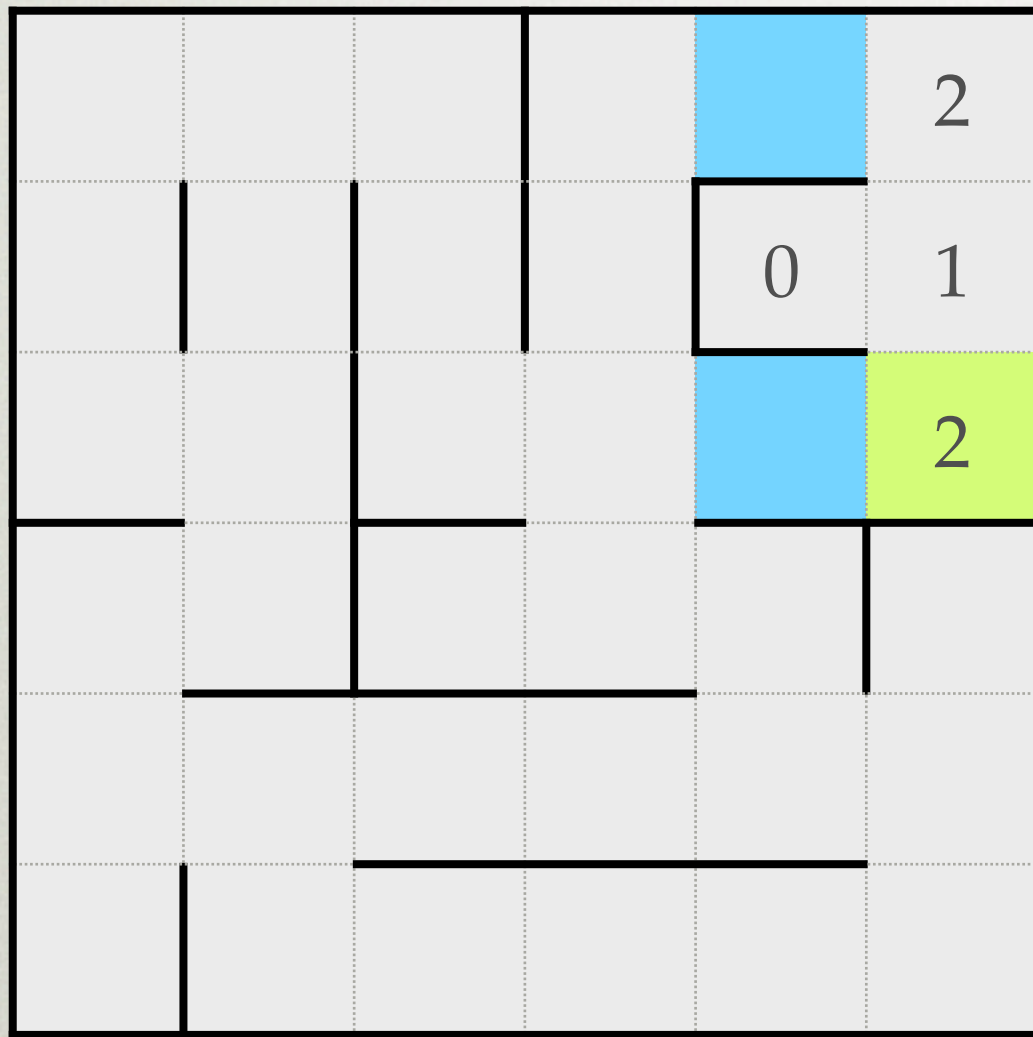
55

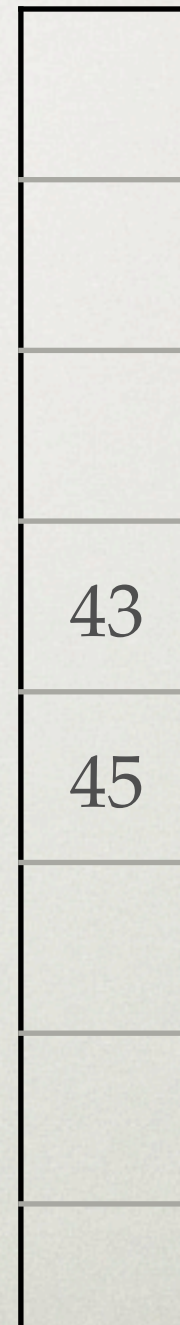
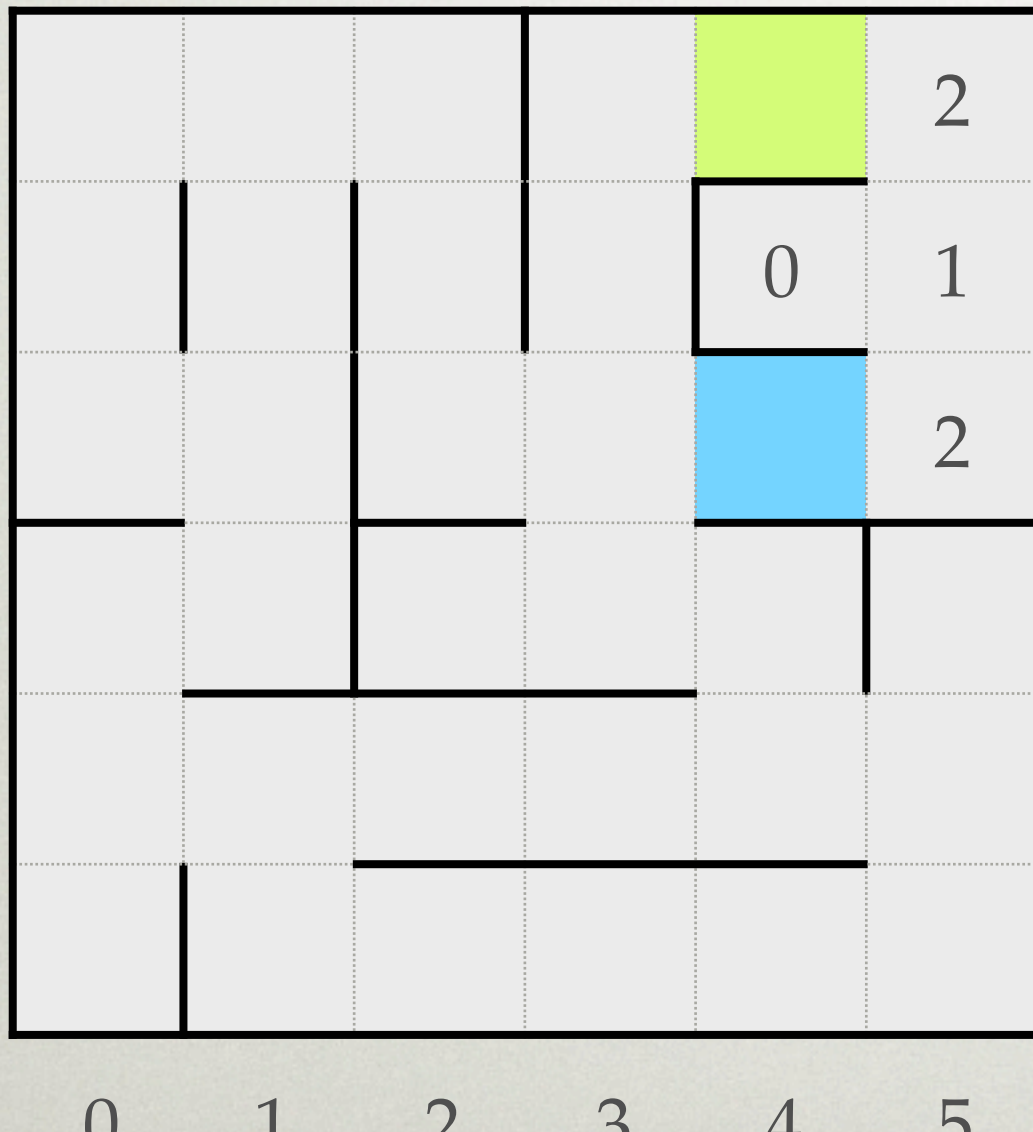
MOVE HEAD

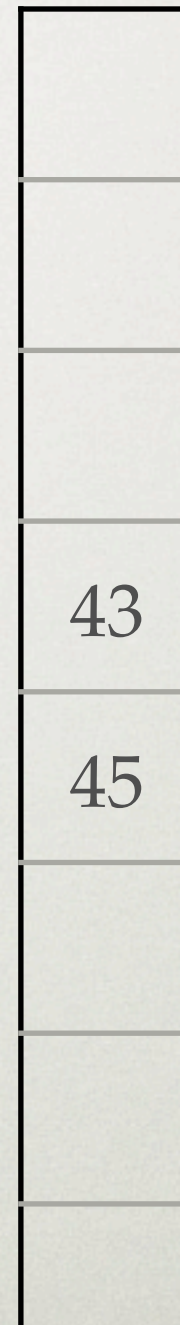
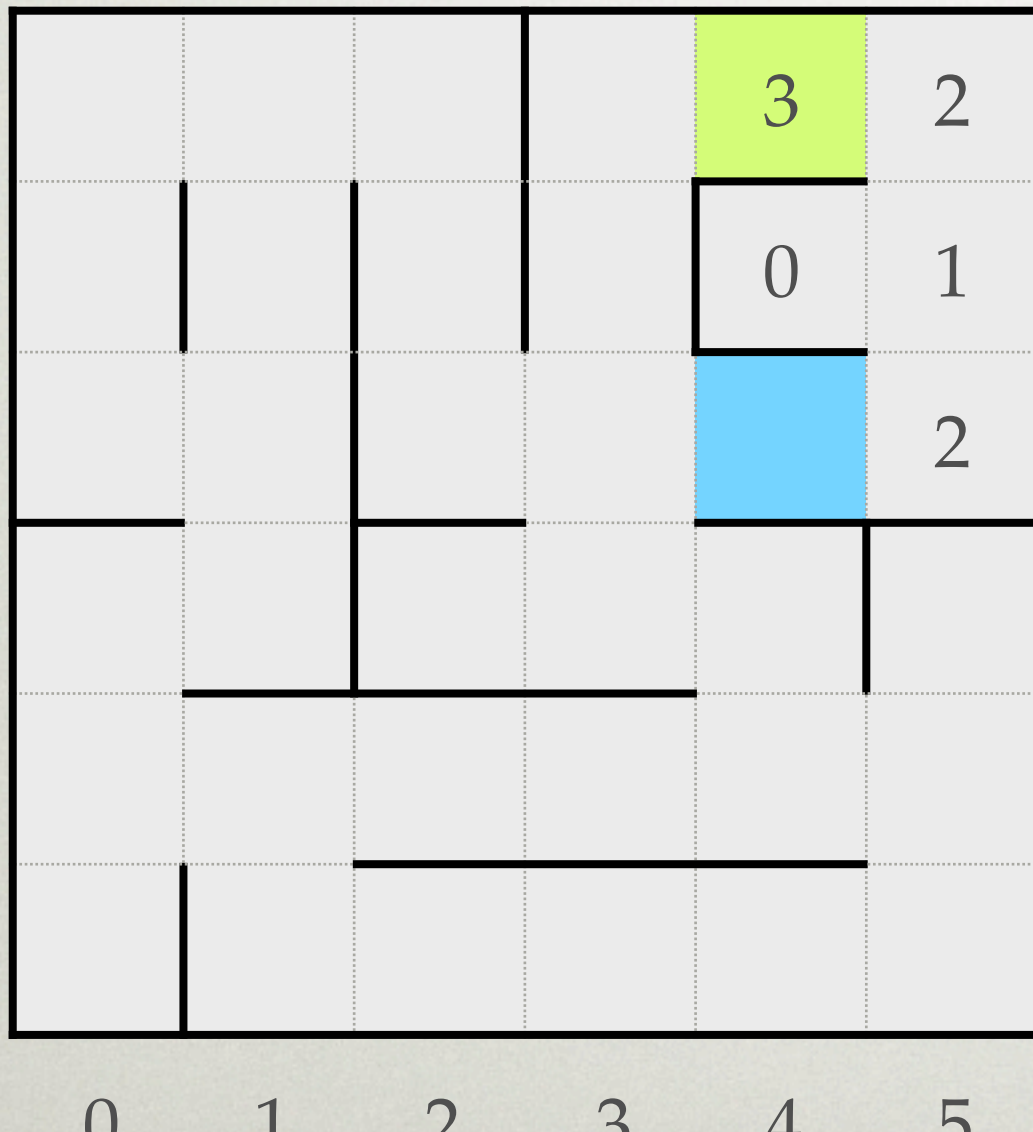


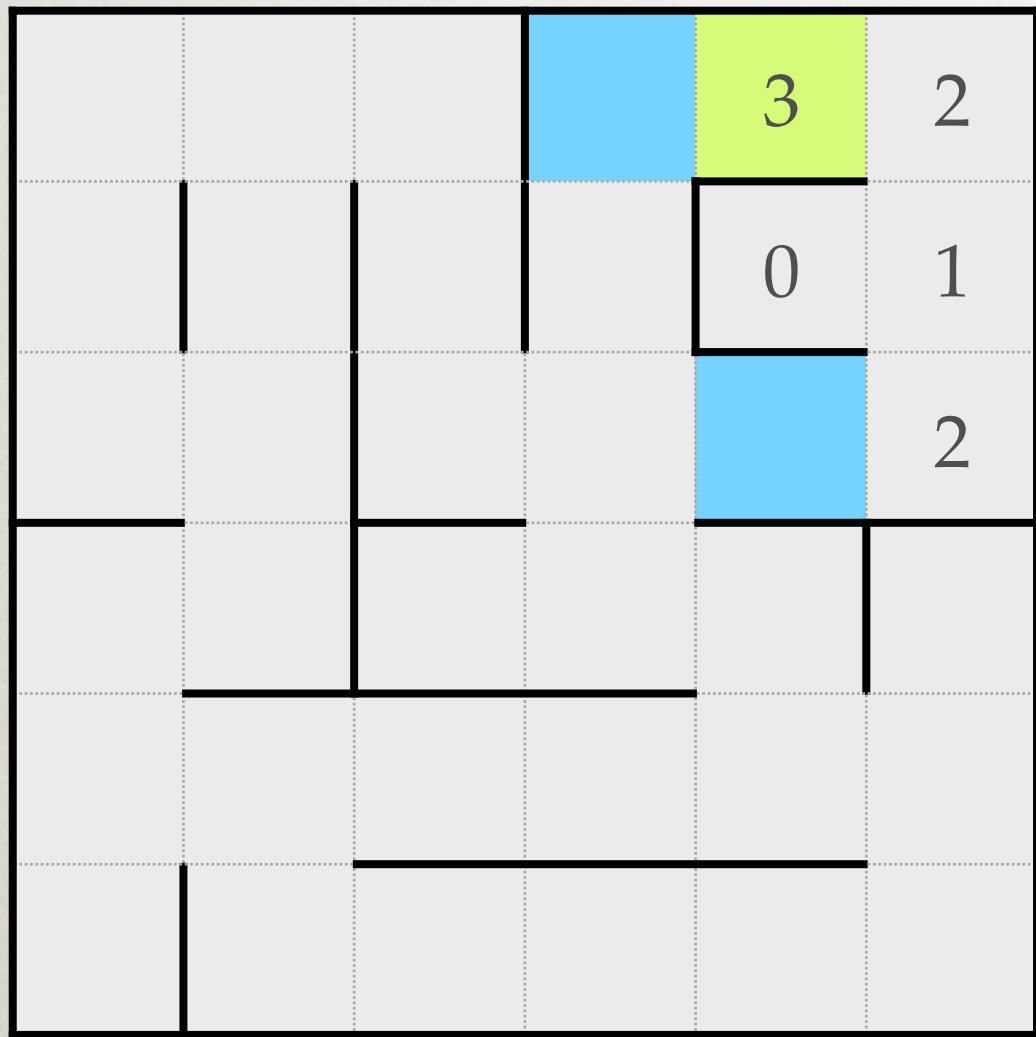
CALCULATE DISTANCE



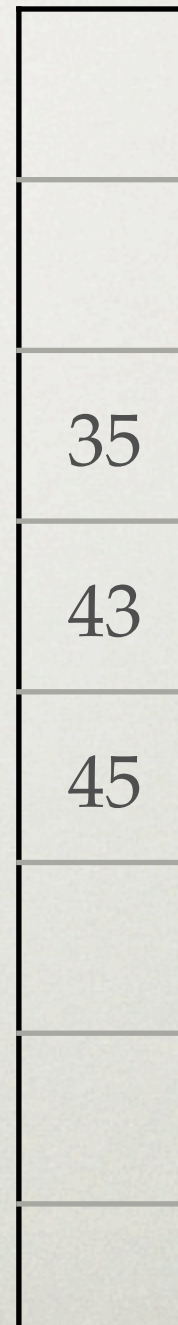


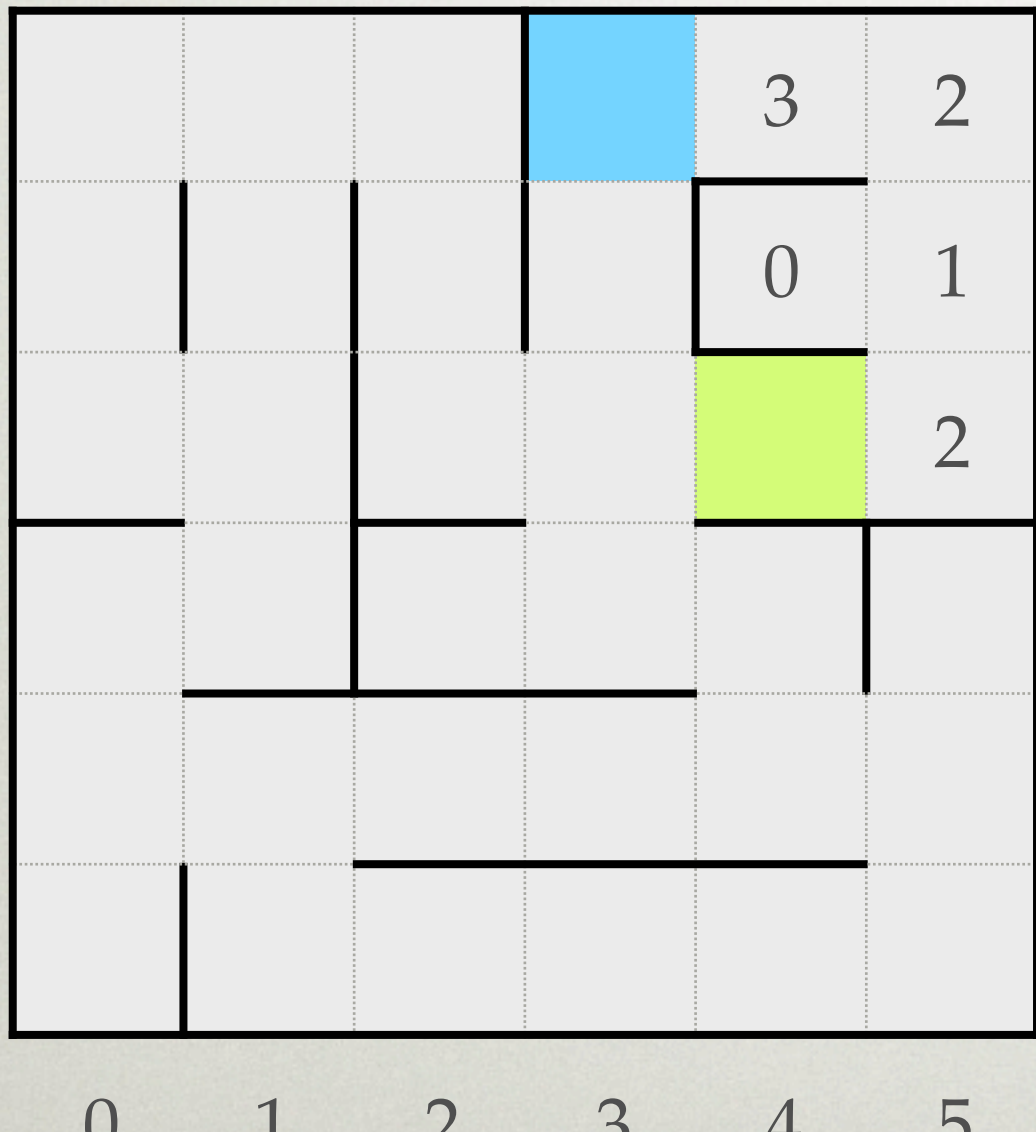






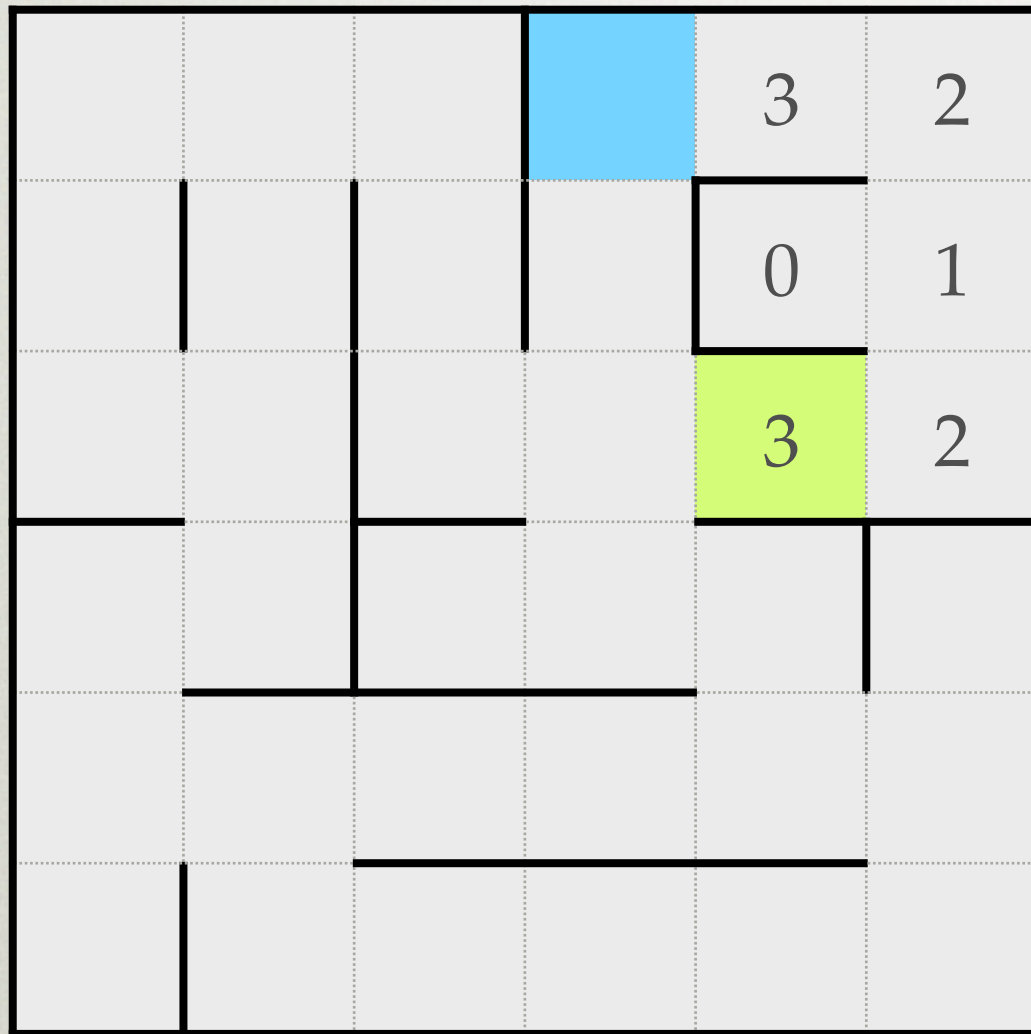
0 1 2 3 4 5





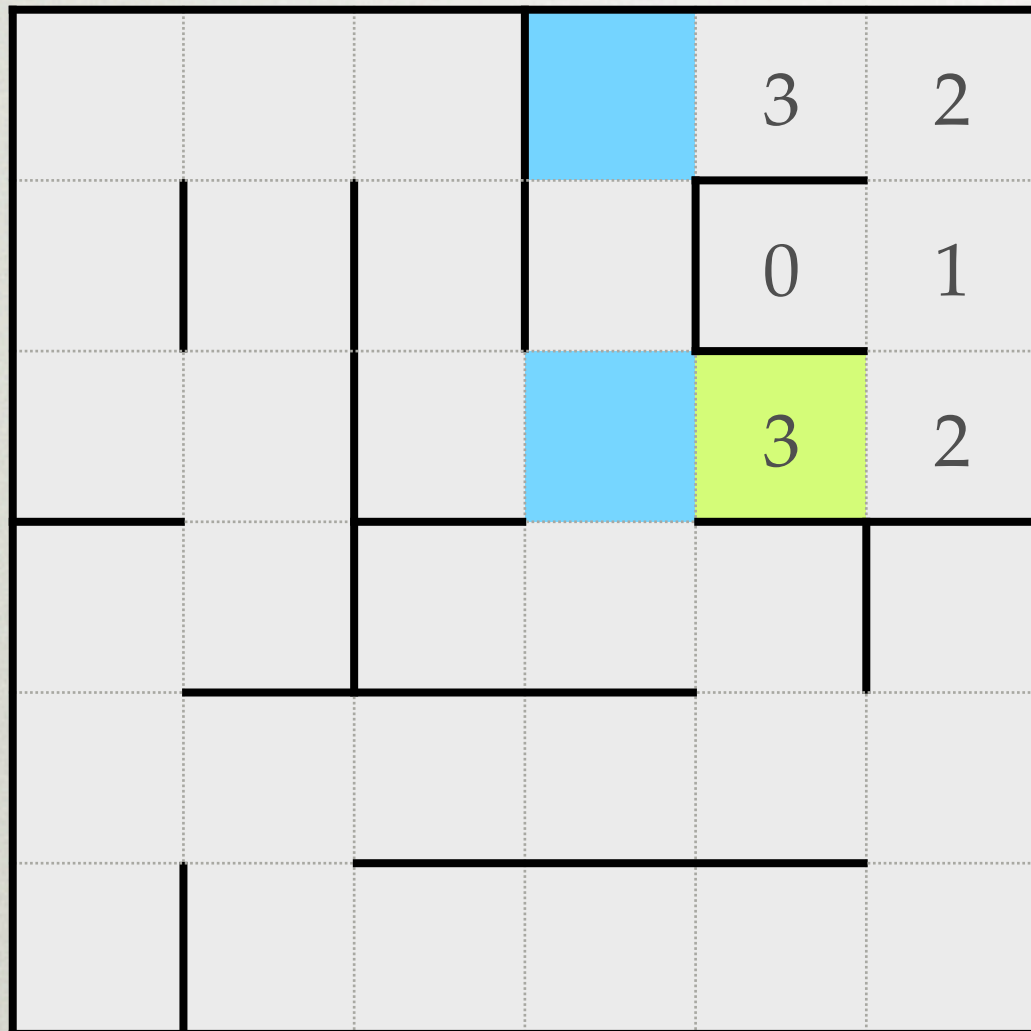
35
43

DISTANCE



35
43

NEIGHBOURS



33

35



43

HEAD

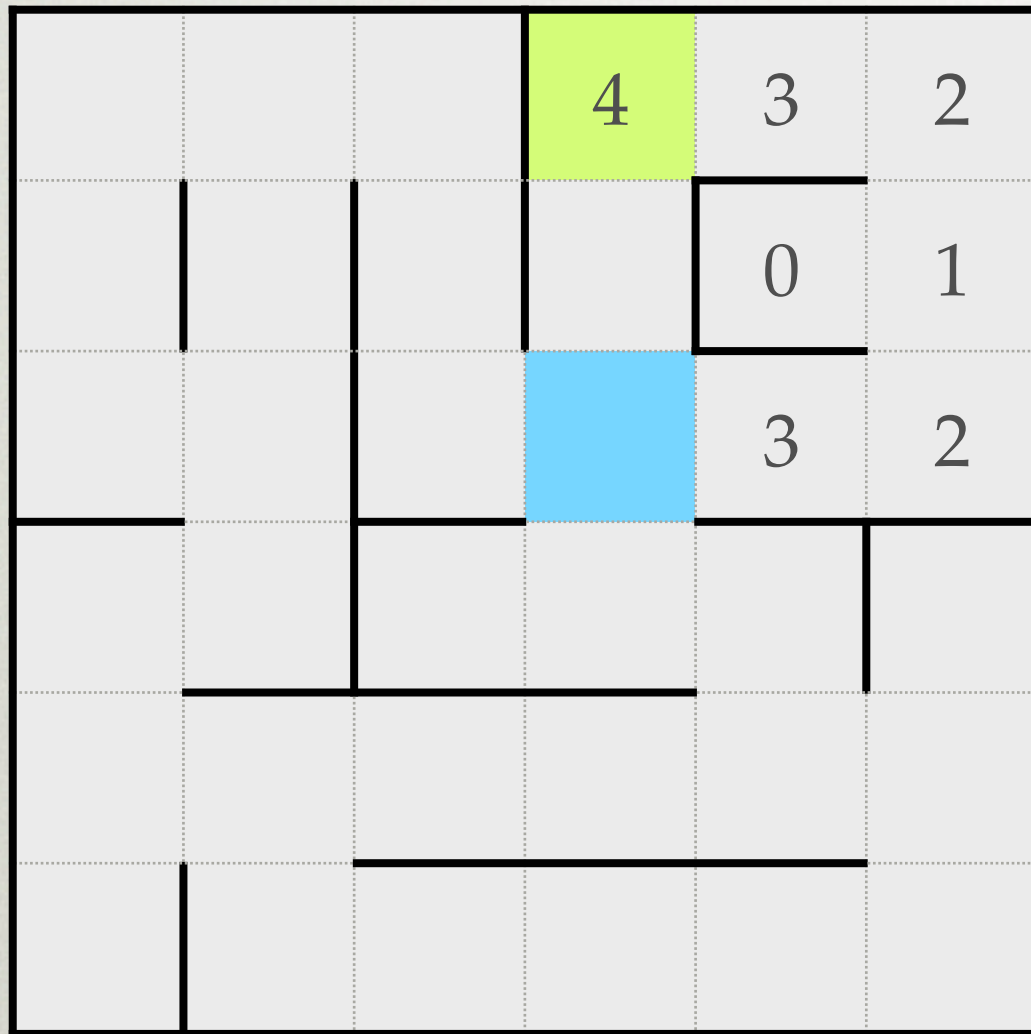
				3	2
				0	1
				3	2

0 1 2 3 4 5



33
35

DISTANCE



33
35

NEIGHBOURS

			4	3	2
				0	1
				3	2

0 1 2 3 4 5



34
33
35



HEAD

			4	3	2
				0	1
				3	2

0 1 2 3 4 5

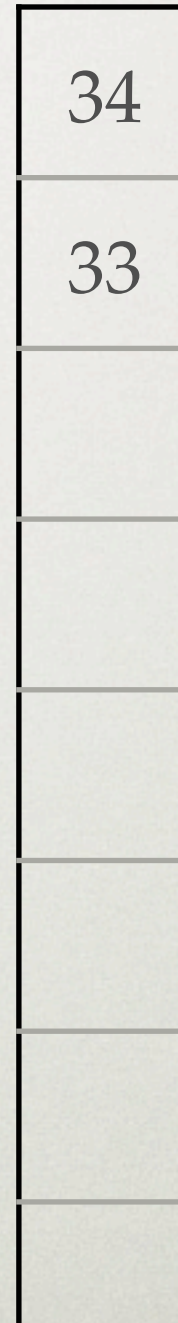
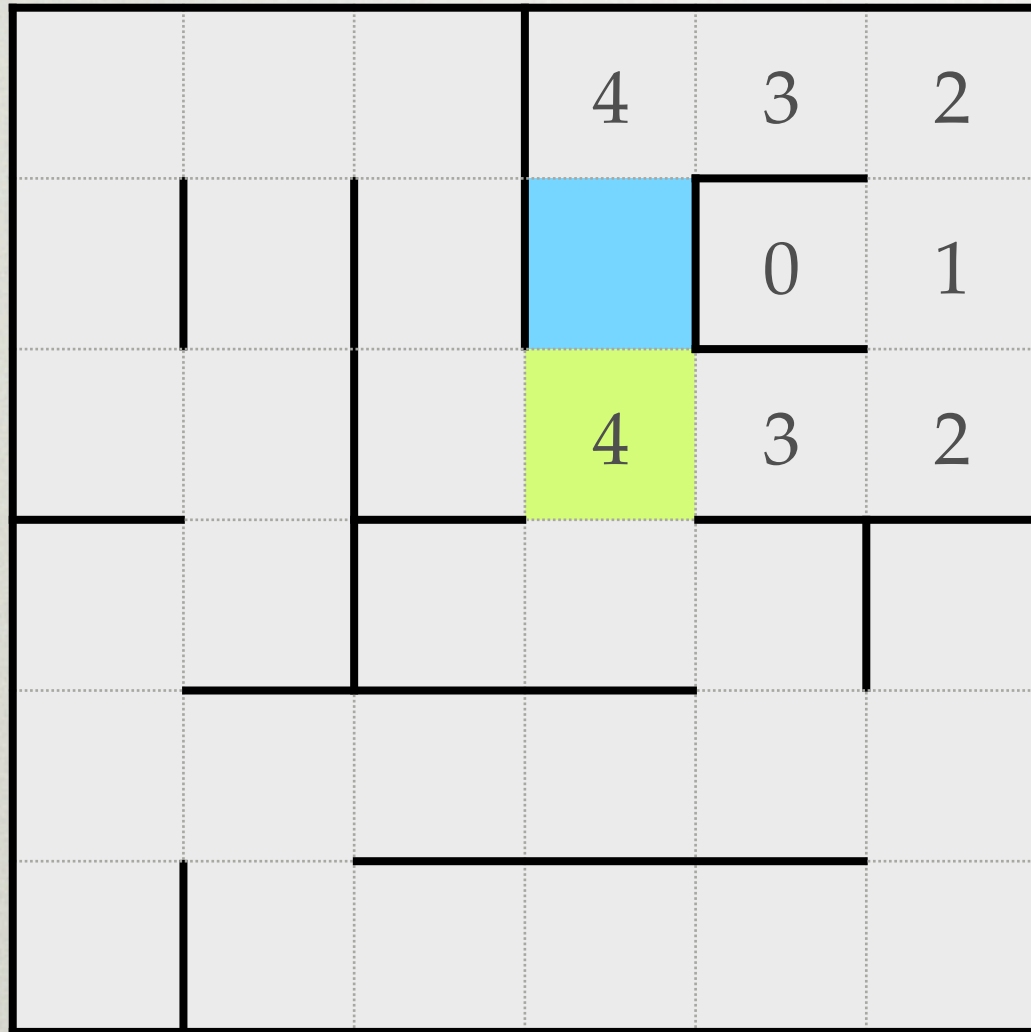


34

33



DISTANCE



NEIGHBOURS

			4	3	2
				0	1

0 1 2 3 4 5



34
33
23
32

HEAD

			4	3	2
				0	1
			4	3	2

0

1

2

3

4

5



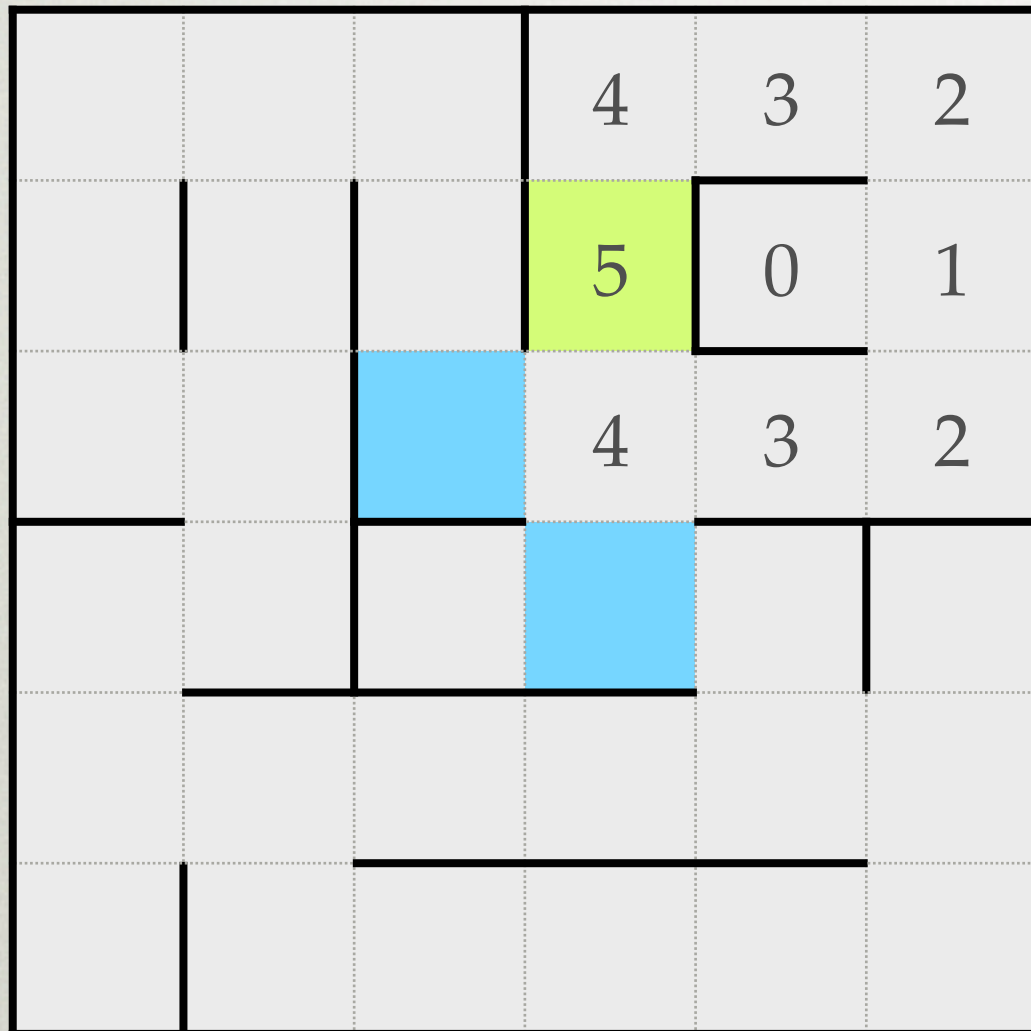
34



23

32

DISTANCE



34



23

32

NEIGHBOURS

			4	3	2
			5	0	1
			4	3	2

0 1 2 3 4 5



34



23

32

A 6x6 grid with the following numbers and features:

- Row 1: 4, 3, 2
- Row 2: 5, 0, 1
- Row 3: 4, 3, 2
- Row 4: (empty), (empty), (empty), (empty), (empty), (empty)
- Row 5: (empty), (empty), (empty), (empty), (empty), (empty)
- Row 6: (empty), (empty), (empty), (empty), (empty), (empty)

Additional features:

- A blue cell is located at Row 3, Column 3.
- A yellow cell is located at Row 4, Column 4.
- Thick black lines are present at the top, bottom, and left edges of the grid.
- Thick black lines also form a 2x2 square in the top-right corner, covering the cells (1,4), (1,5), (2,4), and (2,5).
- Thick black lines also form a 2x2 square in the bottom-left corner, covering the cells (5,1), (5,2), (6,1), and (6,2).

[illegible]



NEIGHBOURS

			4	3	2
			5	0	1
			4	3	2
			5		
0	1	2	3	4	5



22
42
23
32



HEAD

			4	3	2
			5	0	1
			4	3	2
			5		

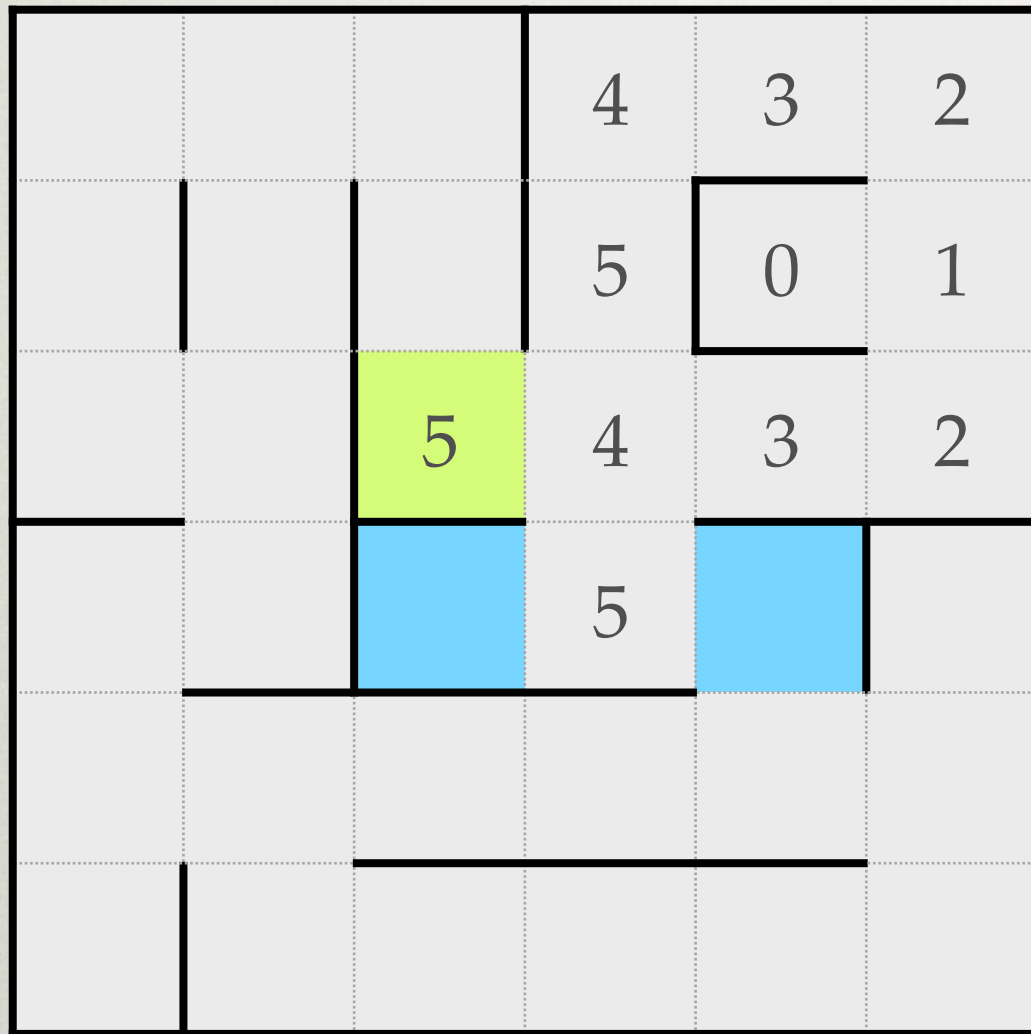
0 1 2 3 4 5



22
42
23



DISTANCE



22
42
23



NEIGHBOURS

			4	3	2
			5	0	1
		5	4	3	2
			5		

0 1 2 3 4 5



24
22
42
23



HEAD

			4	3	2
			5	0	1
		5	4	3	2
			5		

0 1 2 3 4 5



24
22
42

FULL STEP

			4	3	2
			5	0	1
		5	4	3	2
		5	5	6	

0 1 2 3 4 5



41
24
22

FULL STEP

			4	3	2
			5	0	1
		5	4	3	2
		6	5	6	

0 1 2 3 4 5



41
24

FULL STEP

			4	3	2
		6	5	0	1
		5	4	3	2
		6	5	6	

0 1 2 3 4 5



25
41

FULL STEP

			4	3	2
		6	5	0	1
		5	4	3	2
		6	5	6	
				7	

0 1 2 3 4 5



51
25
31

FULL STEP

		7	4	3	2
		6	5	0	1
		5	4	3	2
		6	5	6	
				7	

0 1 2 3 4 5



51



15

31

FULL STEP

		7	4	3	2
		6	5	0	1
		5	4	3	2
		6	5	6	
				7	8

0 1 2 3 4 5



52
51
15
31



FULL STEP

		7	4	3	2
		6	5	0	1
		5	4	3	2
		6	5	6	
			8	7	8
0	1	2	3	4	5



21
52
51
15

FULL STEP

0	1	2	3	4	5



05
14
21
52
51

FULL STEP

	8	7	4	3	2
		6	5	0	1
		5	4	3	2
		6	5	6	
			8	7	8
					9

0

1

2

3

4

5



41
05
14
21
52

FULL STEP

	8	7	4	3	2
		6	5	0	1
		5	4	3	2
		6	5	6	9
			8	7	8
					9

0 1 2 3 4 5



41
05
14
21

FULL STEP

	8	7	4	3	2
		6	5	0	1
		5	4	3	2
		6	5	6	9
		9	8	7	8
					9



41
05
14
11

FULL STEP

	8	7	4	3	2
	9	6	5	0	1
		5	4	3	2
		6	5	6	9
		9	8	7	8
					9

0

1

2

3

4

5



41
05
13
11

FULL STEP

9	8	7	4	3	2
	9	6	5	0	1
		5	4	3	2
		6	5	6	9
		9	8	7	8
					9
0	1	2	3	4	5



41



04

13

11

FULL STEP

9	8	7	4	3	2
	9	6	5	0	1
		5	4	3	2
		6	5	6	9
		9	8	7	8
				10	9
0	1	2	3	4	5



30
04
13
11

FULL STEP

9	8	7	4	3	2
	9	6	5	0	1
		5	4	3	2
		6	5	6	9
	10	9	8	7	8
				10	9
0	1	2	3	4	5



01
10
30
04
13

FULL STEP

9	8	7	4	3	2
	9	6	5	0	1
	10	5	4	3	2
		6	5	6	9
	10	9	8	7	8
				10	9
0	1	2	3	4	5



03
12
01
10
30
04

FULL STEP

9	8	7	4	3	2
10	9	6	5	0	1
	10	5	4	3	2
		6	5	6	9
	10	9	8	7	8
				10	9

0 1 2 3 4 5



03
12
01
10
30

FULL STEP

9	8	7	4	3	2
10	9	6	5	0	1
	10	5	4	3	2
		6	5	6	9
	10	9	8	7	8
			11	10	9
0	1	2	3	4	5



03
12
01
10
20

FULL STEP

9	8	7	4	3	2
10	9	6	5	0	1
	10	5	4	3	2
		6	5	6	9
	10	9	8	7	8
	11		11	10	9
0	1	2	3	4	5



03
12
01
20

FULL STEP

9	8	7	4	3	2
10	9	6	5	0	1
	10	5	4	3	2
		6	5	6	9
11	10	9	8	7	8
	11		11	10	9
0	1	2	3	4	5



03
12
00
02
20

FULL STEP

9	8	7	4	3	2
10	9	6	5	0	1
	10	5	4	3	2
	11	6	5	6	9
11	10	9	8	7	8
	11		11	10	9
0	1	2	3	4	5



03



00

02

20

FULL STEP

9	8	7	4	3	2
10	9	6	5	0	1
11	10	5	4	3	2
	11	6	5	6	9
11	10	9	8	7	8
	11		11	10	9
0	1	2	3	4	5



00
02
20

FULL STEP

9	8	7	4	3	2
10	9	6	5	0	1
11	10	5	4	3	2
	11	6	5	6	9
11	10	9	8	7	8
	11	12	11	10	9
0	1	2	3	4	5



00
02

FULL STEP

9	8	7	4	3	2
10	9	6	5	0	1
11	10	5	4	3	2
12	11	6	5	6	9
11	10	9	8	7	8
	11	12	11	10	9
0	1	2	3	4	5



00

SOLVED

9	8	7	4	3	2
10	9	6	5	0	1
11	10	5	4	3	2
12	11	6	5	6	9
11	10	9	8	7	8
12	11	12	11	10	9

head and tail point to same value so the queue is empty



0 1 2 3 4 5

HOW FAST IS THAT?

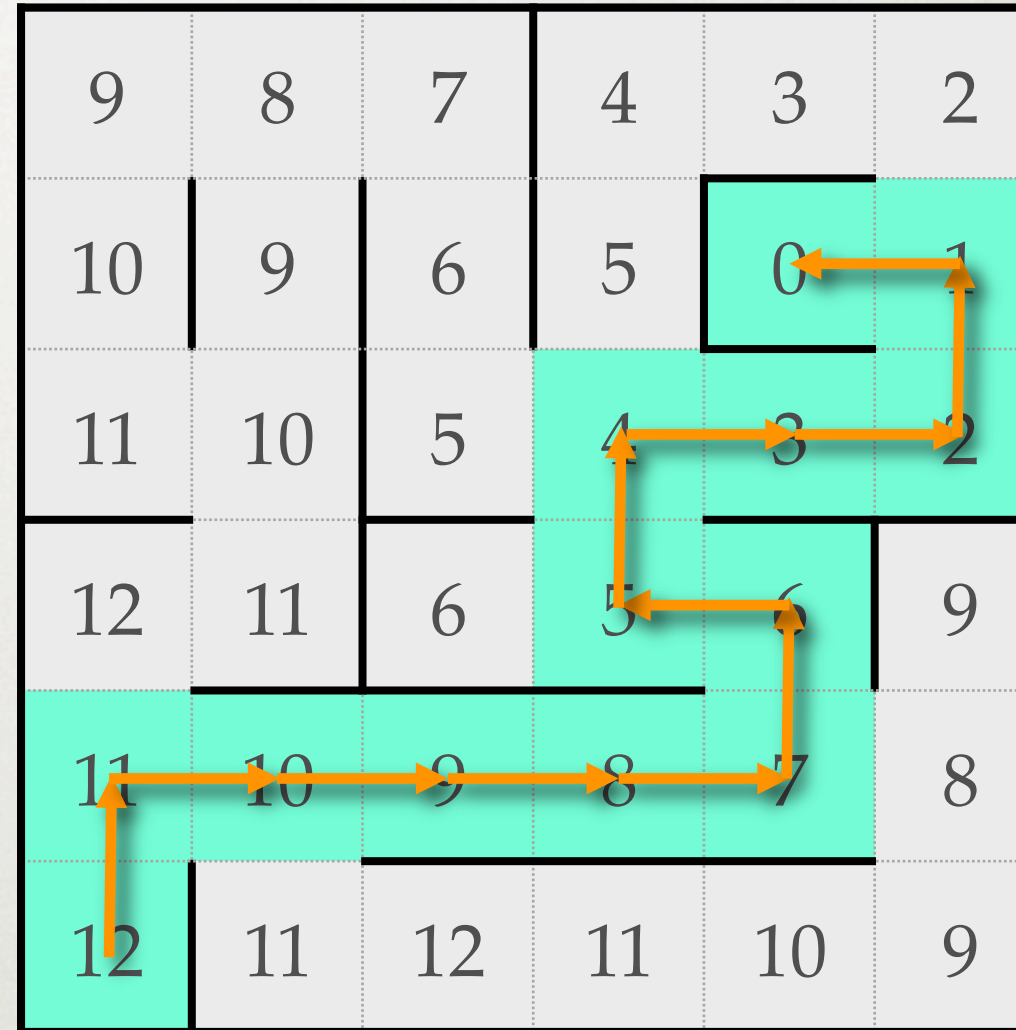
- dsPIC30F4011 @ 32MHz, C30
- Japan 2007 maze
- No optimisation
 - Simple flood: 41.91ms
 - Fast flood: 3.75ms, 139 words
- Optimisation O1
 - Simple flood: 24.19ms
 - Fast flood: 1.74ms, 63 words

HOW FAST IS THAT?

- PIC18F4525 @ 32MHz, C18
- Japan 2007 maze
- No optimisation
 - Simple flood: 46.9ms, 291 words
 - Fast flood: 5.95ms, 374 words
- Optimisation - full
 - Simple flood: 52.8ms, 166 words
 - Fast flood: 7.6ms, 196 words

CREATING THE PATH

- Walk downhill
- Run length encode result



F RFFFF LF LF RF RFF LF LF
1R4L1L1R1R2L1L1

CREATING DIAGONALS

- Still downhill
- Pattern matching
 - 19 patterns / rules
 - 7 cell look-ahead
 - messy at best
- Make more - do less
- Use half-cells?

A 6x6 grid with numbers and a highlighted path. The grid is divided into four quadrants by a thick black cross. The numbers in the grid are as follows:

9	8	7	4	3	2
10	9	6	5	0	1
11	10	5	4	3	2
12	11	6	5	6	9
11	10	9	8	7	8
12	11	12	11	10	9

The highlighted path (orange arrows) starts at cell (1,5) with value 1, moves left to (1,4) with value 0, then down to (2,4) with value 3, then left to (2,3) with value 4, then down to (3,3) with value 5, then left to (3,4) with value 6, then down to (4,4) with value 7, then left to (4,3) with value 8, then left to (4,2) with value 9, then left to (4,1) with value 10, then down to (5,1) with value 12, and finally up to (5,1) with value 12.

HHRHHHHHHHLLHHLHHRHHRHHHLLHHLHH
1R4L1L1R1R2L1L1

CREATING DIAGONALS

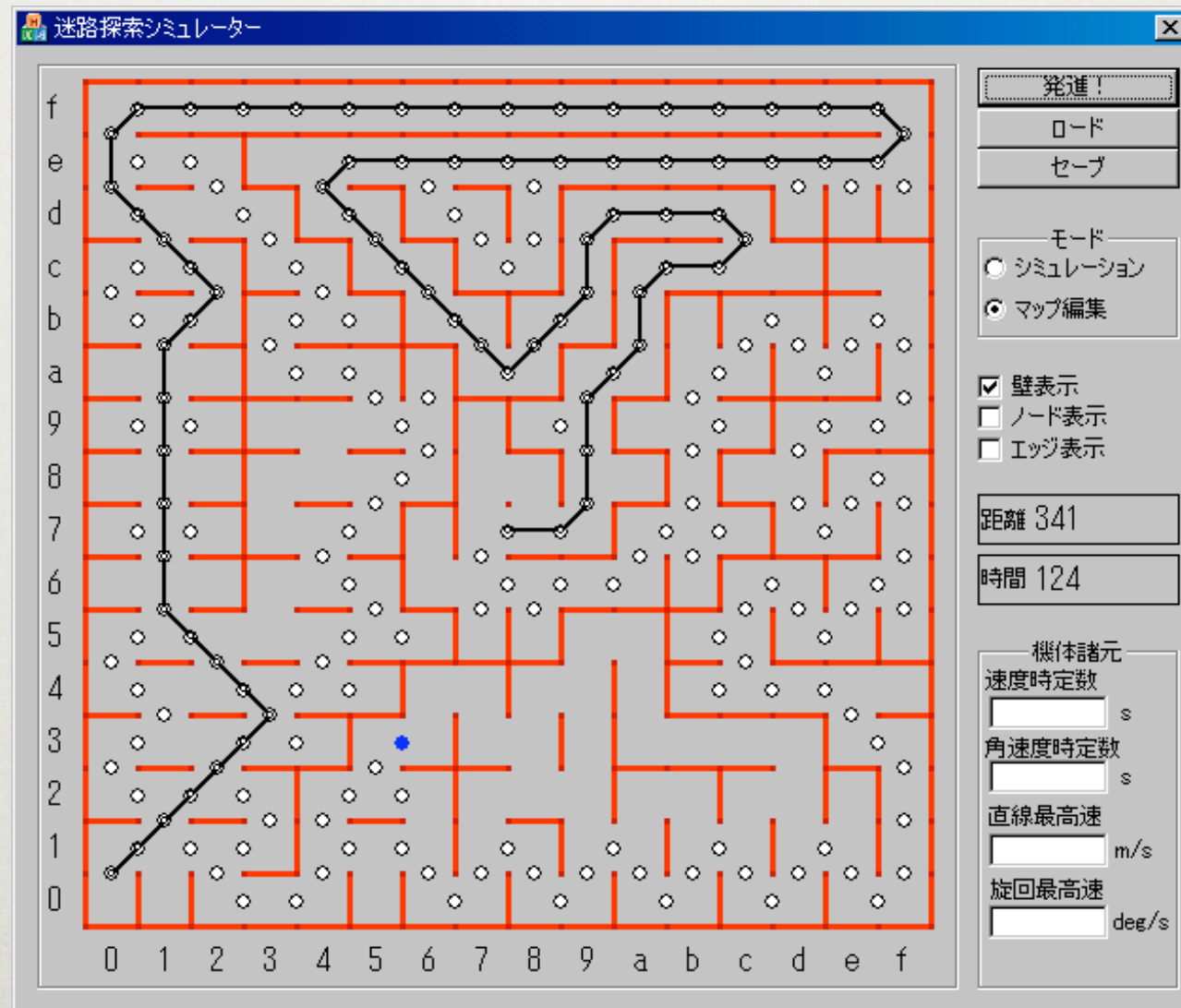
- Still pattern matching
- 7 patterns
- 6 cell look-ahead
- Turns are left as an exercise for the reader (this is not a good example)

9	8	7	4	3	2
10	9	6	5	0	1
11	10	5	4	3	2
12	11	6	5	6	9
11	10	9	8	7	8
12	11	12	11	10	9

H HRH HHHHHH HLH HLH HRH HRH HH HLH HLH H
 H TDT HHHHHH TDT TDDT TDT HH TDT TDT H

HALF-CELL GRIDS

- It may be easier to work on a half-cell grid in the first place



89	87	85	82	83	7f	75	73	71	6e	6f	65	63	61	5f	5d	5b	59	57	55	53	51	4e	4f	4d	4b	48	47
8a			80	7c	76				6c	66												4c					45
8d			7f	7d	7b	78	79		6b	68	69	57	55	53	51	4f	4c	4b				4b	49	47	44	43	
8f									6a			58			50	49					4c					41	
91	92	95	97	99	9b	9d	9f	a1	a3	a5	6d	5b	58	59		51	47	48	4b	4d	4f					3f	
93									a6		6f			56		4f	45									3d	
95	96	99	9b	9d	9f	a1	a3	a5	a9	71	72	75	55	53	51	4e	4d	43	44	47	45	43	41	3f	3c	3b	
97									a6	ab	73			58		4b	40									39	
99	9a	9d	9f	a1	a3	a5	a9	ad	75	53	50	51				49	3f	3d	3b	38	39					37	
9b									a6	ab	af	77			4e	46	40					36				34	
9d	9e	a1	a3	a5	a9	a8	ab	ad	af	79	7a	7d	4d	4b	49	47	45	42	43			37	34	33	32	35	
9f									a6																	30	
a1	a2	a5	a9	a8	ab	ad	af	b3	17	18	1b	1d	1f	1c	1b	1c	1f	21	23	25	27	29	2b	2d	2f	31	33
									a4																	34	
ab	a8	a7	a6	a9	ab	ad	b3	b7	13	2	2	2	17	55	52	53	49	46	47							37	
aa							ae	b5	11	2	0	2	15	56	50	4a	44									39	
ad	ae	b1	b3	b5	b2	b1	b7	c1	f	2	2	2	13	59	4f	4c	4d	43	41	3f	3c	3b					
									b0																		
b7	b4	b3	c3	c1	bf	bc	bb	bd	b	8	7	8	b	d	f	5d	5e	61	63	65	67	69	6b	6d	6f	71	
b6			c2					ba														6a				72	
b9	ba	bd	bf	c1	c1	bf	bd	bb	b9	b7	b5	b2	b1	b2	b5	7d	7b	79	77	75	73	71	6e	6d	91	75	
bb					c2									af		7e	7a								8f	77	
bd	be	c1	c3	c5	c4	c5	b5	b3	b1	ae	af	ad	83	80	81	7d	7e	81	83	85	87	89		8d	79		
bf			c3				b6		ac	ab			83	7f					86					8b	7b		
c1	c5	c2	c1	b7	b8	b9			ad	aa	a9	aa	ad	85	82	81			89		8b	88	89		7d		
c3	c6	bf	b4									a7		84	83				8b				86	7f			
c5	c6	c5	bd	b3	b1	af	ad	ab	a9	a7	a4	a5	89	86	87	85	86	89	8b	8d	8e	91	85	82	81		
c7	c3	ba	b4									a2	89	87										84			
c9	c1	b9	b6	b7	af	ad	ab	a8	a9	a3	a0	a1	8b	8a	89	8a	8d	8f	8d	8b	89	86	87	88	8b		
cb	be						b0	ac	a6				9e								88				8a		
cd	bd	bb	b9	b7	b5	b2	b3	af	a5	a3	a1	9f	9d	9b	99	97	95	93	91	8f	8d	8a	8b	8c	8f	8e	8d

CalcNum:57

CalcNum:57

17 18 1b 1d 1f 1c 1b 1c 1f 21 23

15

19

13

2 2 2

17

55 52 53

11

2 0 2

15

56

50

f

2 2 2

13

59

4f

c

5

10

5b

b

8

7

8

b

d

f

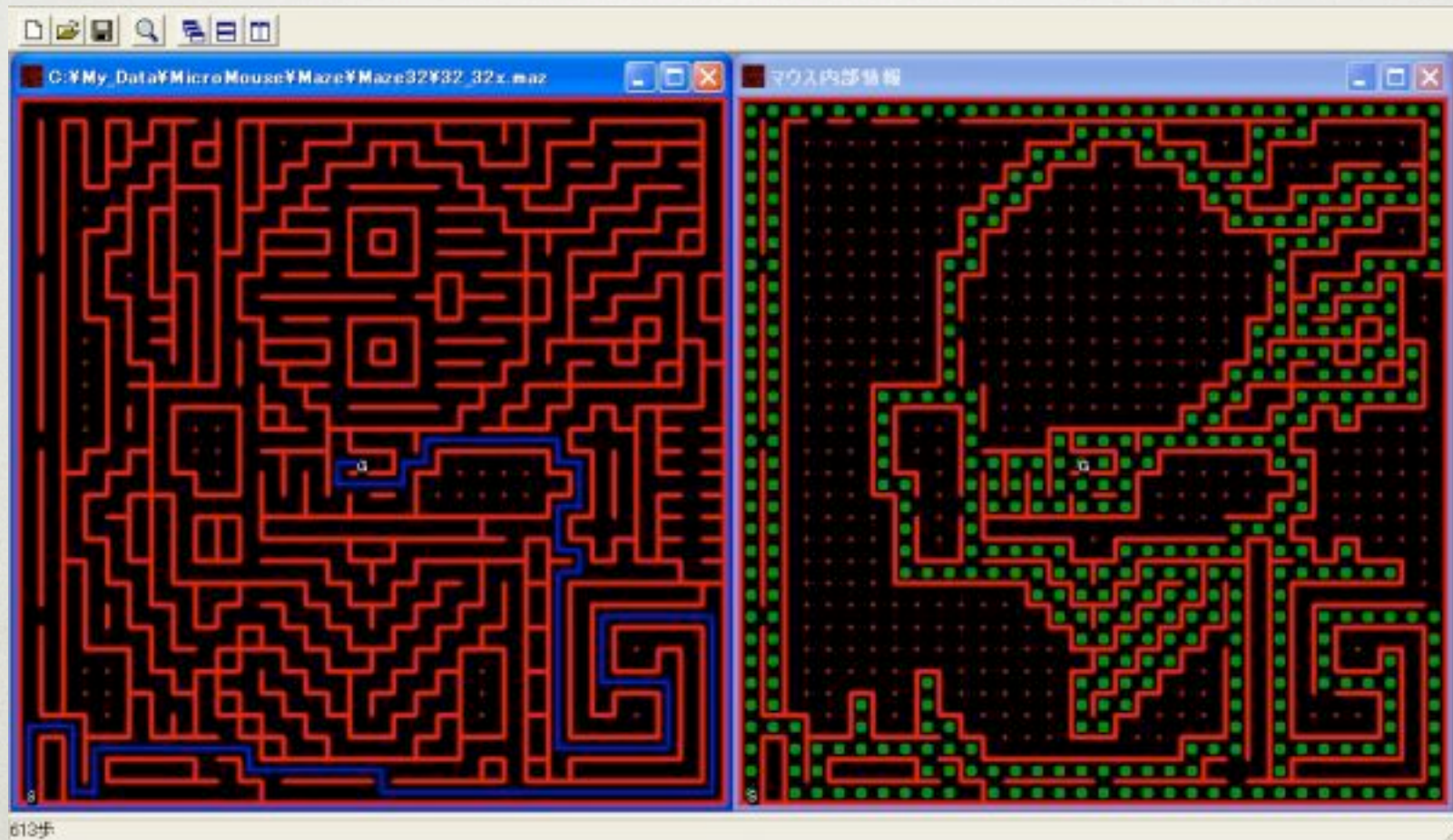
5d 5e 61

FOUR TIMES AS BIG



<http://www24.atwiki.jp/mm3sakusya/pages/28.html>

FOUR TIMES AS BIG



THANK YOU
PETER HARRISON

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