

16

	Dead			
	0	1	2	3
	4	5	6	7
	8	9	10	11
	12	13	14	15
	16	17	18	19
	20	21	22	23
	24	25	26	27
	28	29	30	31
	32	33	34	35
	36	37	38	39
	40	41	42	43
	44	45	46	47
	48	49	50	51
	52	53	54	55
	56	57	58	59
	60	61	62	63

16

Dead

now -  
 $64 \times \text{int } 16 +$   
 $4 + 4 (\text{bpx, my})$

int:  
 (16)

--	--	--	--

4 memory to 16 sum


$$N = M[(i-1) \% 4]$$

$$S = M[(i+1) \% 4]$$

$$W = M[i] \gg 4 \quad | \quad (0b1111 \ 0000 \ 0000 \ 0000 \ 0000) \& M[i-1]$$

$$E = M[i] \ll 4 \quad | \quad (0b0000 \ 0000 \ 0000 \ 0000 \ 1111) \& M[i+1]$$

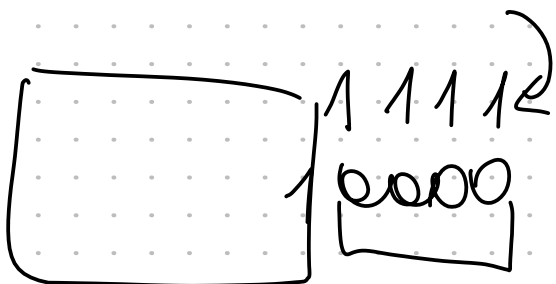
$f(\text{ceil}:1, \text{count}:3)$

	count				
dead	0	0	0	0	1
	0	0	0	1	
	0	0	1	0	
	0	0	1	1	
	0	1	0	0	
	0	1	0	1	
	0	1	1	0	
	0	1	1	1	
	1	0	0	0	1
	1	0	0	1	
	1	0	1	0	
	1	0	1	1	
	1	1	0	0	
	1	1	0	1	
	1	1	1	0	
	1	1	1	1	
a b c d					

Dead and  $011_2 = 3_{10}$  neighbours

Alive and  $010_2 = 2_{10}$  neighbours  
 $011_2 = 3_{10}$  neighbours

$$f(a, b, c, d) = (\bar{a} \& \bar{b} \& \overset{\textcircled{1}}{c} \& \overset{\textcircled{2}}{d}) \vee (\bar{a} \& \bar{b} \& \overset{\textcircled{3}}{c} \& \overset{\textcircled{4}}{d}) \vee (\bar{a} \& \bar{b} \& \overset{\textcircled{5}}{c} \& \overset{\textcircled{6}}{d})$$



minimization

① & ③  $\bar{b}cd(\bar{a} \vee a) = \bar{b}cd$  ④

② & ④  $\bar{b}cd \vee a\bar{b}cd = \bar{b}c(d \vee a) \overset{(*)}{=} \underline{\underline{\bar{b}c(d \vee a)}}$

$$f(a, b, c, d) = \bar{b}c(d \vee a)$$

$$A + \bar{A}B = A + B \quad (*)$$

A	B	$A + \bar{A}B$	$A + B$
0	0	0	0
0	1	1	1
1	0	1	1
1	1	1	1

$$N = \overline{abcd}_2 = (N \& 0b0100) \& N \& 0b0010 \& (N \& 0b0001 \mid N \& 0b1000)$$

```
int countNeighbours_4(int word) {
    return (((word & 0b0100010001000100) ^ 0b0100010001000100) >> 2) &
    ((word & 0b0010001000100010) >> 1) &
    ((word & 0b0001000100010001) | (word & 0b1000100010001000) >> 3);
}
```

$\ll 3$   
корректирует формат

```
void next_gen(unsigned short field[], unsigned short write[]) {
    for (unsigned short i = 1; i <= SIZE; i++) { // row
        for (unsigned short j = 1; j <= 4; j++) { // one of 4 ceil
            unsigned short c = field[i * 6 + j];
            unsigned short N = field[(i - 1) * 6 + j];
            unsigned short S = field[(i + 1) * 6 + j];
            unsigned short W = ((field[i * 6 + (j - 1)] & 0b0000000000001111) << 12 | (c >> 4));
            unsigned short E = ((field[i * 6 + (j + 1)] & 0b1111000000000000) >> 12 | (c << 4));
            unsigned short NW = ((field[(i - 1) * 6 + (j - 1)] & 0b0000000000001111) << 12 | (N >> 4));
            unsigned short NE = ((field[(i - 1) * 6 + (j + 1)] & 0b1111000000000000) >> 12 | (N << 4));
            unsigned short SW = ((field[(i + 1) * 6 + (j - 1)] & 0b0000000000001111) << 12 | (S >> 4));
            unsigned short SE = ((field[(i + 1) * 6 + (j + 1)] & 0b1111000000000000) >> 12 | (S << 4));
            unsigned short neighbours = (N >> 3) + (S >> 3) + (E >> 3) + (W >> 3) + (NW >> 3) + (NE >> 3) + (SW >> 3) + (SE >> 3);
            unsigned short word = neighbours | c;
            unsigned short new = countNeighbours_4(word);
            write[i * 6 + j] = new;
        }
    }
}
```

убрать умножение на 6

$$i = 1 \dots 16$$

$$i \cdot 6$$

$$(i-1) \cdot 6 = 6i - 6$$

$$(i+1) \cdot 6 = 6i + 6$$

$$k = 6, 12, \dots, 96$$

$$k$$

$$k - 6$$

$$k + 6$$

# Memory mapped I/O

① Display: 0xf fd0 - 0xf fef

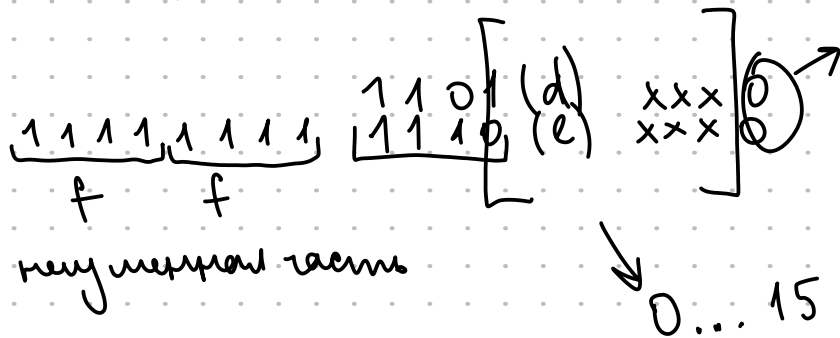
16 words x 16 bits

1 word - 1 column

0xf fd0 - 0

0xf fd2 - 1

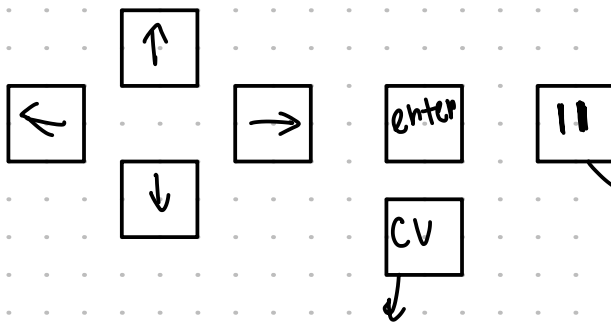
0xf fd4 - 2.



тём/свет Satin в  
чёрке  
номер бага  
в тём, но  
чёрке (не Satin)

② Keyboard

game\_state: { is-paused  
x-coord  
y-coord  
cursor visi... } непомню  
улица



cursor visibility