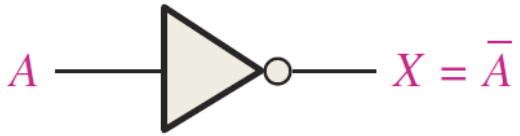
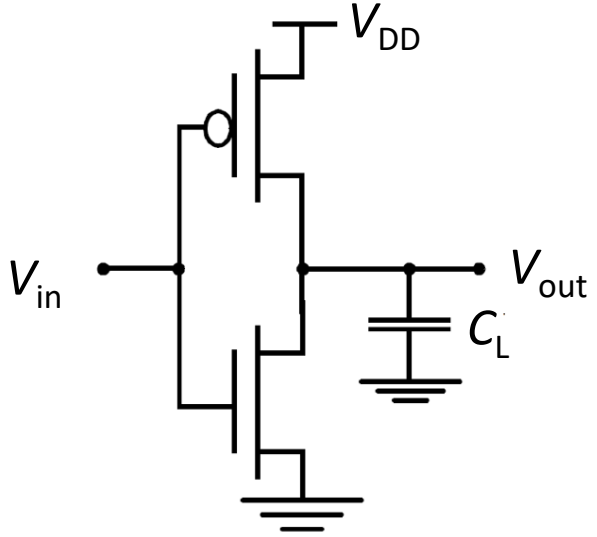
NOT function (Inverter)

- Boolean expression $X = \overline{A}$
- Truth table

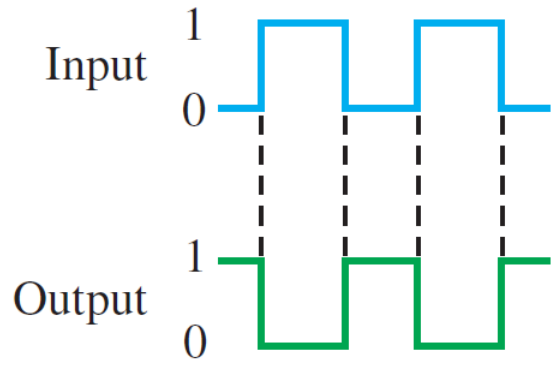
Input	Output
LOW (0)	HIGH (1)
HIGH (1)	LOW (0)

- Logic circuit





Circuit implementation



Waveform

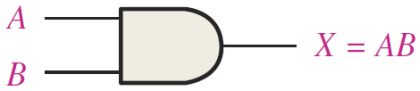
AND operation

- Boolean expression $X = AB$

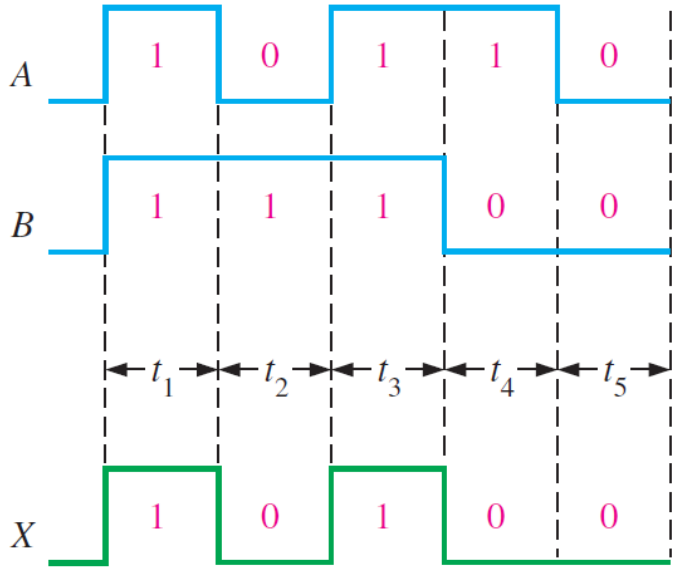
- Truth table

Inputs		Output
A	*B*	*X*
0	0	0
0	1	0
1	0	0
1	1	1

- Logic circuit

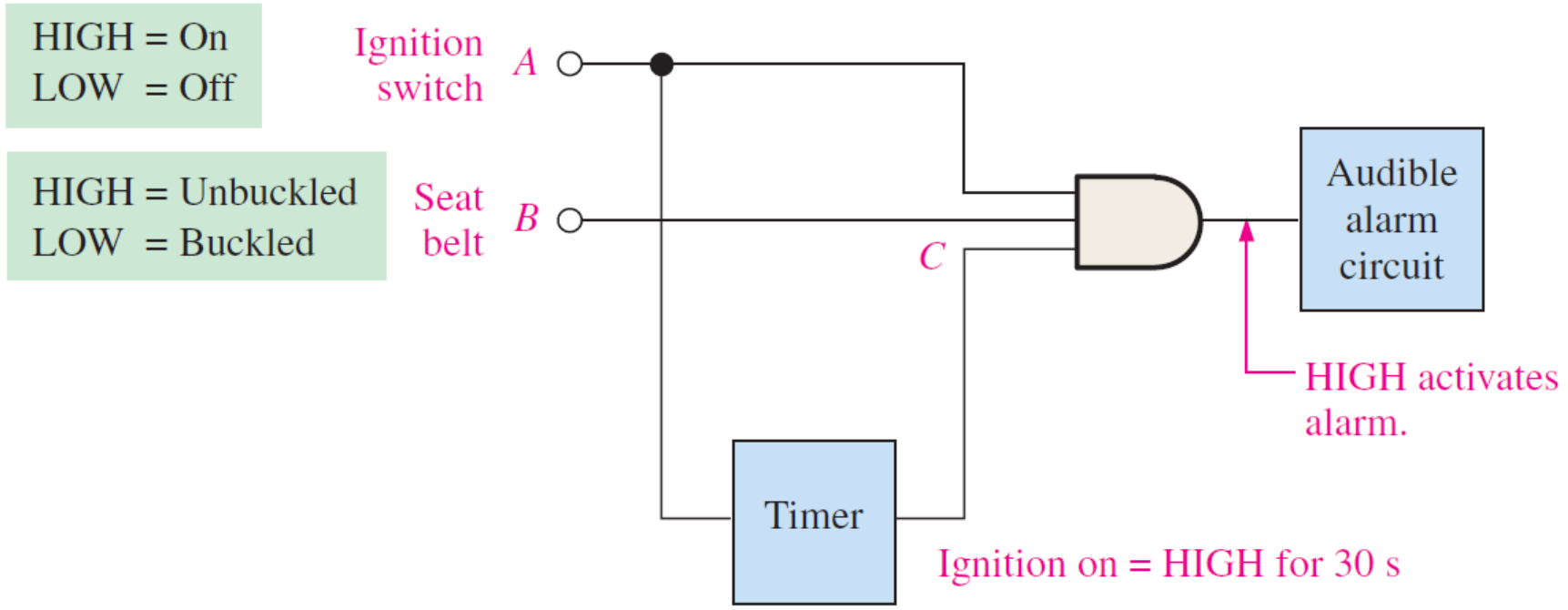


Inputs			Output
A	*B*	*C*	*X*
0	0	0	0
0	0	1	0
0	1	0	0
0	1	1	0
1	0	0	0
1	0	1	0
1	1	0	0
1	1	1	1



Application of AND gate

Seat Belt Alarm System

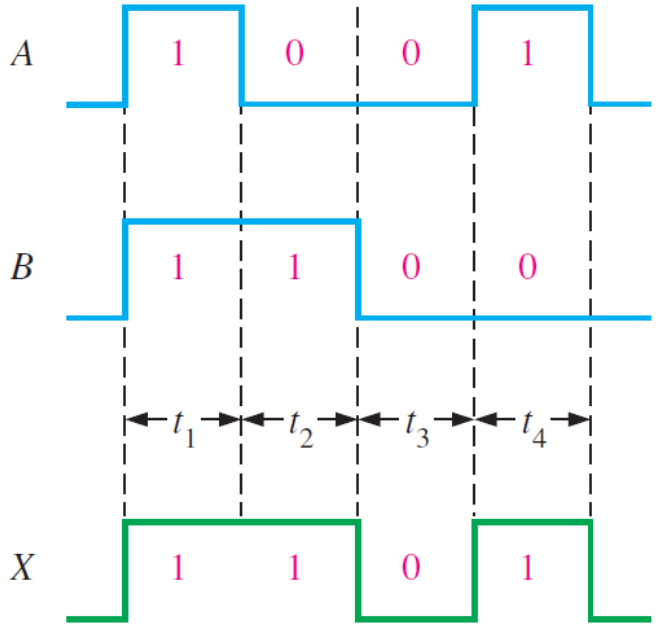


If the ignition is on and the seat belt is unbuckled and the timer is running, the output is HIGH.

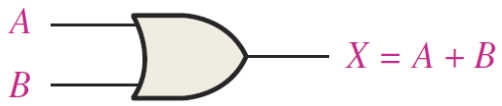
OR operation

- Boolean expression $X = A + B$
- Truth table

A	B	$A + B = X$
0	0	$0 + 0 = 0$
0	1	$0 + 1 = 1$
1	0	$1 + 0 = 1$
1	1	$1 + 1 = 1$

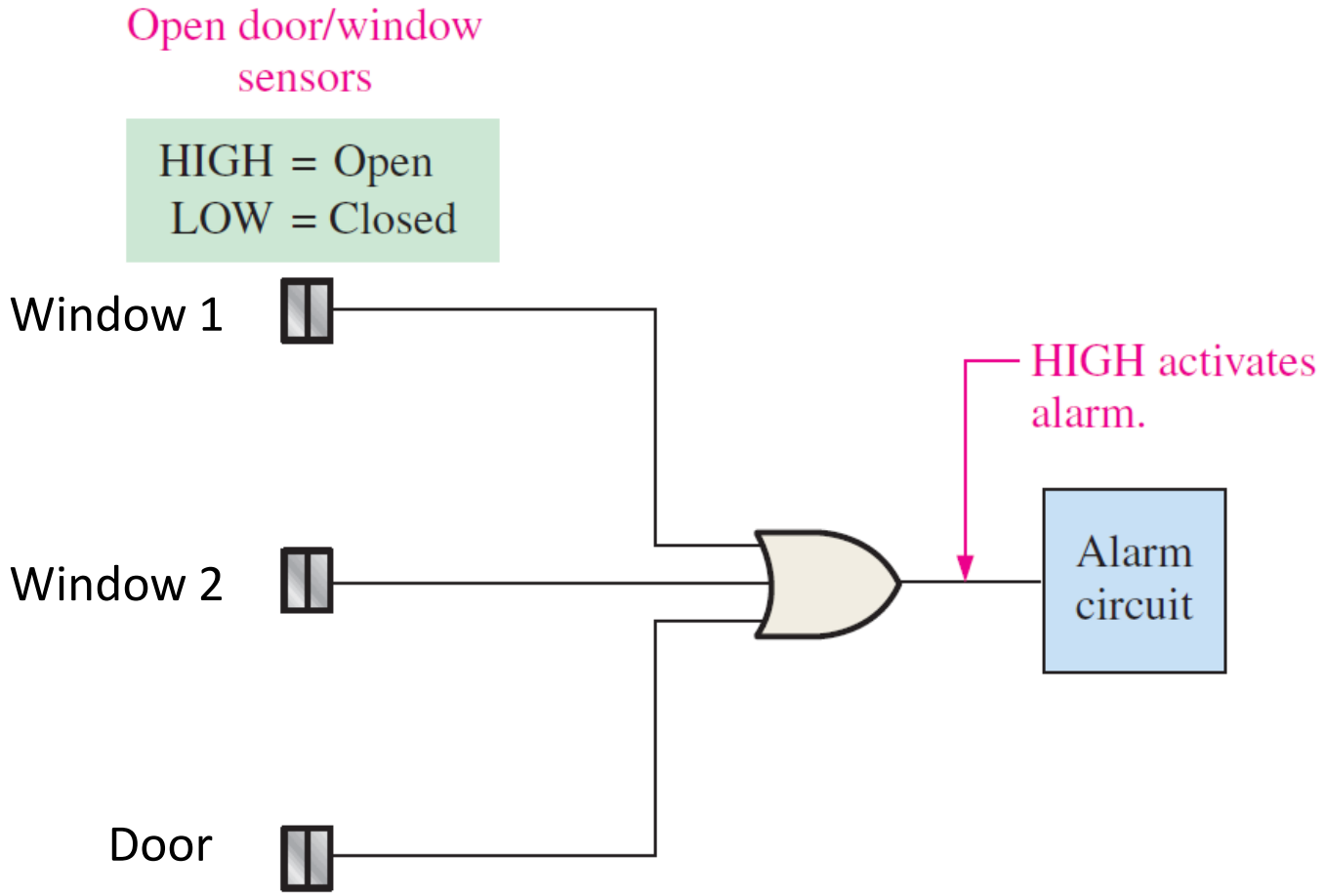


- Logic circuit



Question: draw the truth table for 3-input OR gate

Application of OR gate



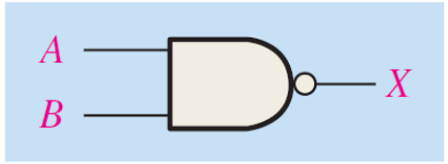
When one of the windows or the door is opened, the gate output goes HIGH.

NAND gate

- Boolean expression

$$X = \overline{AB}$$

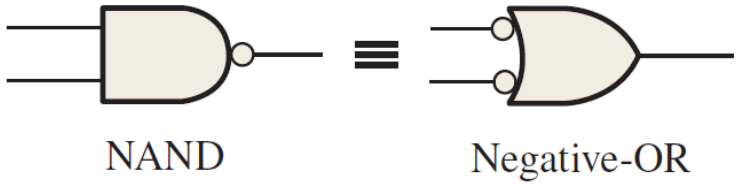
- Logic circuit



- Truth table

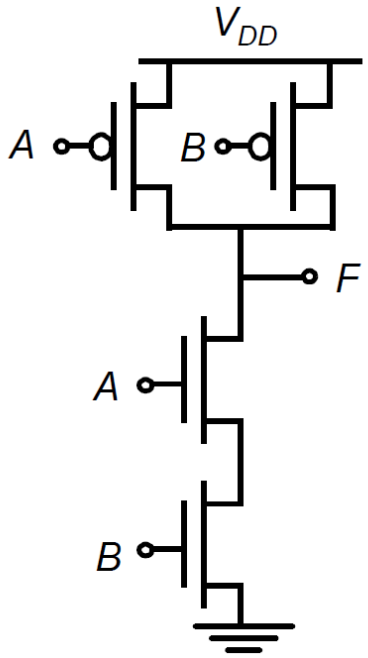
Inputs		Output
A	*B*	*X*
0	0	1
0	1	1
1	0	1
1	1	0

- Inherent in a NAND gate's operation is the fact that one or more LOW inputs produce a HIGH output



$$\overline{AB} = \overline{A} + \overline{B}$$

Verify this using truth table



Circuit

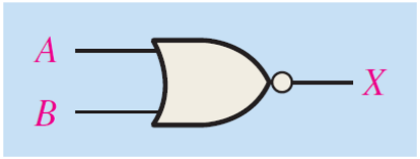
Question: draw the truth table for 3-input NAND gate

NOR gate

- Boolean expression

$$X = \overline{A + B}$$

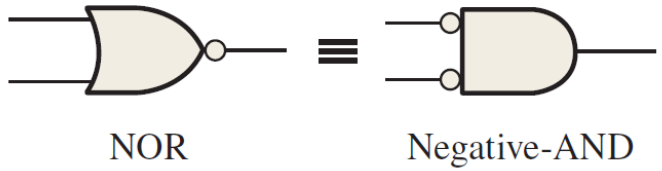
- Logic circuit



- Truth table

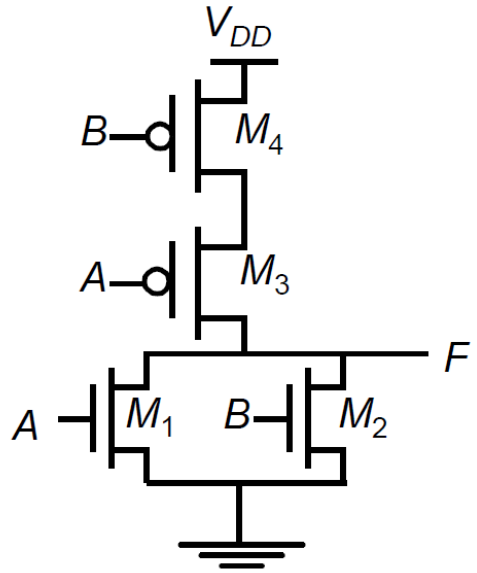
Inputs		Output
A	B	X
0	0	1
0	1	0
1	0	0
1	1	0

- A HIGH is produced on the gate output only when all of the inputs are LOW



$$\overline{A+B} = \overline{A} \cdot \overline{B}$$

Verify this using truth table



Circuit

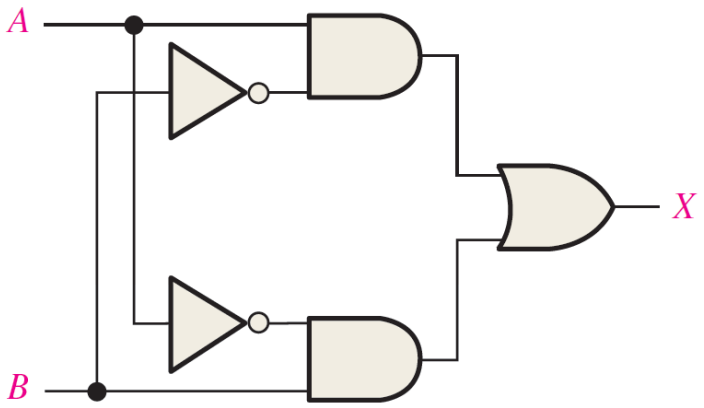
Question: draw the truth table for 3-input NOR gate

Exclusive-OR (XOR) gate

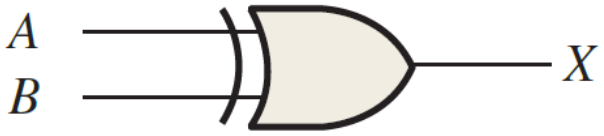
- The output of XOR is HIGH only when the two inputs are at opposite logic levels.
- Truth table

Inputs		Output
A	*B*	*X*
0	0	0
0	1	1
1	0	1
1	1	0

- Boolean expression $X = A\overline{B} + \overline{A}B$ or $X = A \oplus B$



- Logic circuit



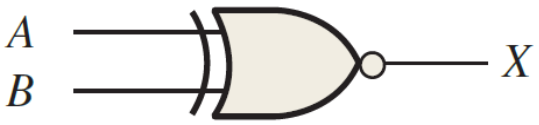
Question: draw the truth table for 3-input XOR gate

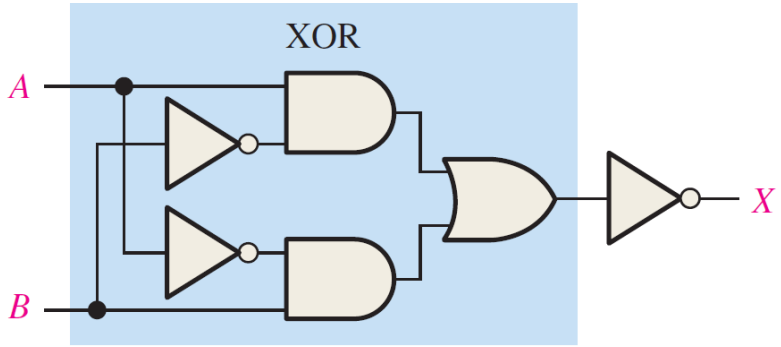
Exclusive-NOR (XNOR) gate

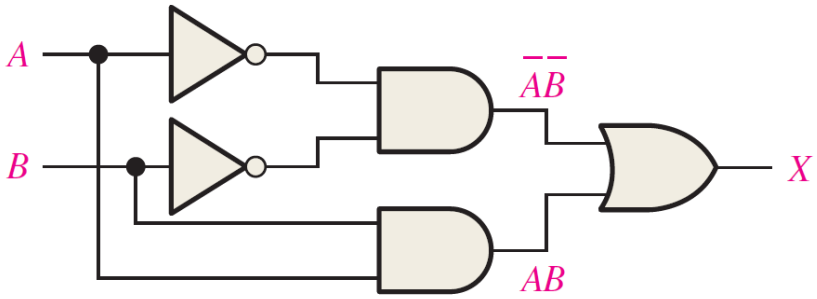
- The output of XNOR is LOW only when the two inputs are at opposite logic levels.
- Truth table

Inputs		Output
A	*B*	*X*
0	0	1
0	1	0
1	0	0
1	1	1

- Boolean expression $X = \overline{A}\overline{B} + AB$
- Logic circuit







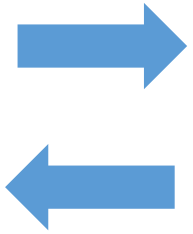
Think about it:

- In the truth table with two inputs, how many lines? How many columns?

Truth Table & Boolean Expression

Even or odd 1s

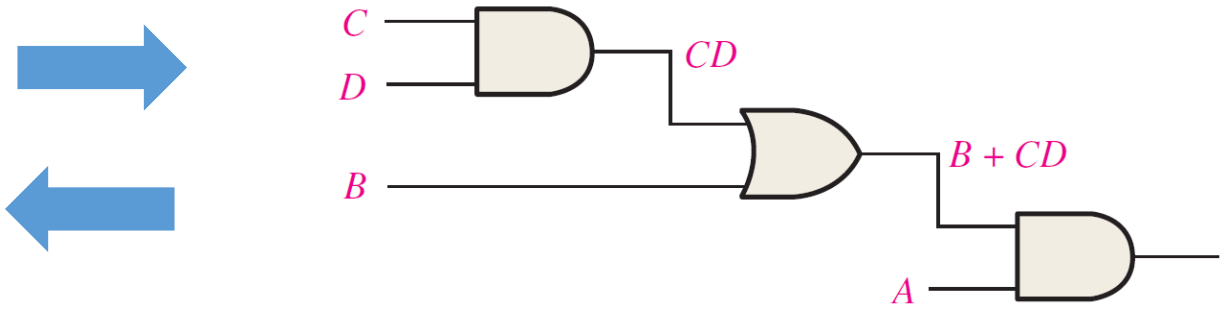
A	B	C	Y
0	0	0	0
0	0	1	0
0	1	0	0
0	1	1	1
1	0	0	0
1	0	1	1
1	1	0	1
1	1	1	0



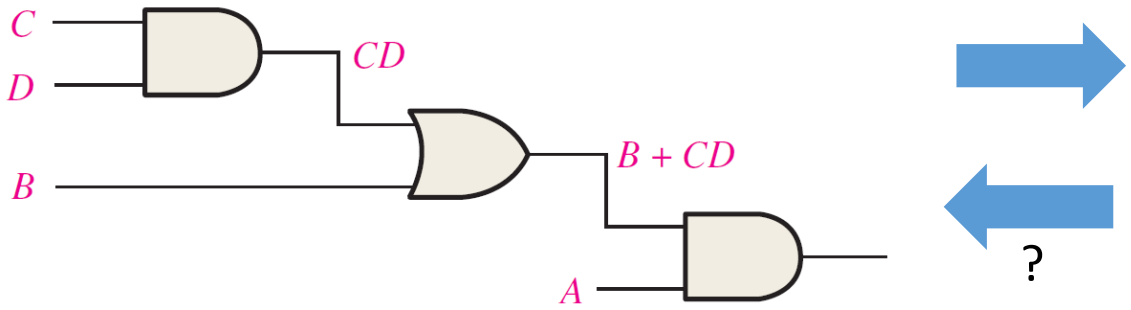
y = A’BC + AB’C + ABC’

Boolean Expression & Logic Circuit

$A(B + CD)$



Truth Table & Logic Circuit



Inputs				Output
A	*B*	*C*	*D*	*A*(*B* + *CD*)
0	0	0	0	0
0	0	0	1	0
0	0	1	0	0
0	0	1	1	0
0	1	0	0	0
0	1	0	1	0
0	1	1	0	0
0	1	1	1	0
1	0	0	0	0
1	0	0	1	0
1	0	1	0	0
1	0	1	1	1
1	1	0	0	1
1	1	0	1	1
1	1	1	0	1
1	1	1	1	1

Reading materials

- Chapter 3 of Floyd book