Performing Arithmetic&Logic Operations on Quantum Computer

Ali Hakim Taşkiran
Department of Electrical&Electronics Engineering

What is Logic?

***"The science of thinking about or explaining the reason for something using formal methods."*[1]**

Logic enables us to relate and link statements.

Statement

***"Something that you say or write that gives information or an opinion."*[1]**

"Ankara is capital of Turkey"(True)

"Books are printed on paper"(True)

"Inconsistent behaviour is consistent"(False)

Role of Statements in Logic

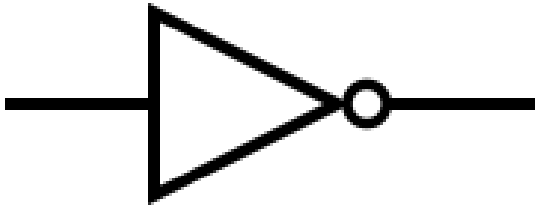
Reality may be unreal **and** it may be real**.**

NOT

“used to give the following word or phrase a negative meaning”[1]

I did **not** buy **apple**

A	A’
1	0
0	1



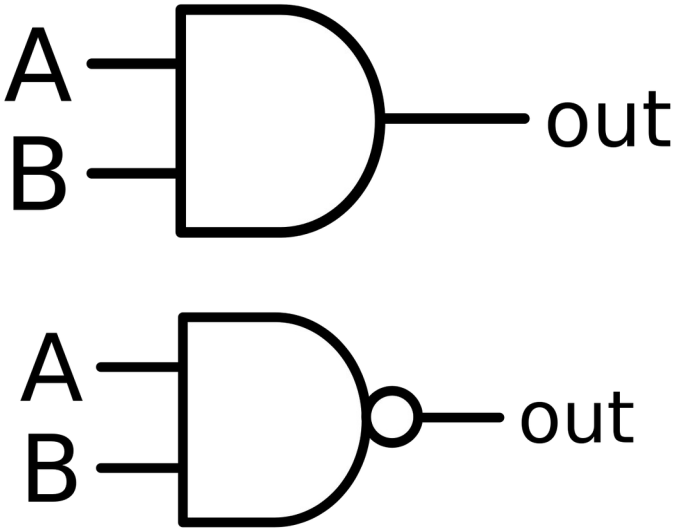
AND

“Used to connect words or parts of sentences”[1]

I bought **apple and banana** from market

*Both of them

A	B	A&B
1	1	1
1	0	0
0	1	0
0	0	0

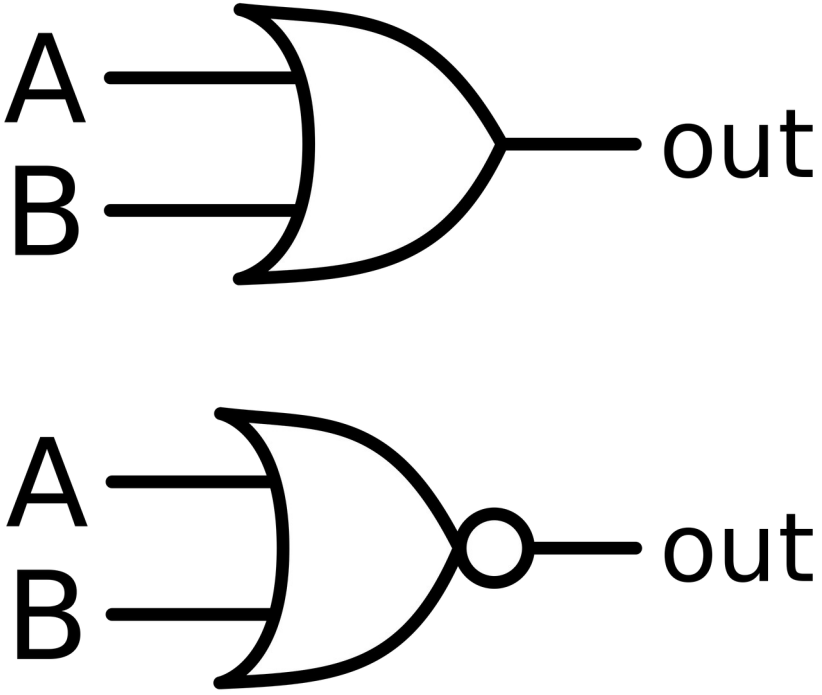


OR

“Used to introduce another possibility”[1]

I bought **apple or banana** from market

A	B	A || B
1	1	1
1	0	1
0	1	1
0	0	0



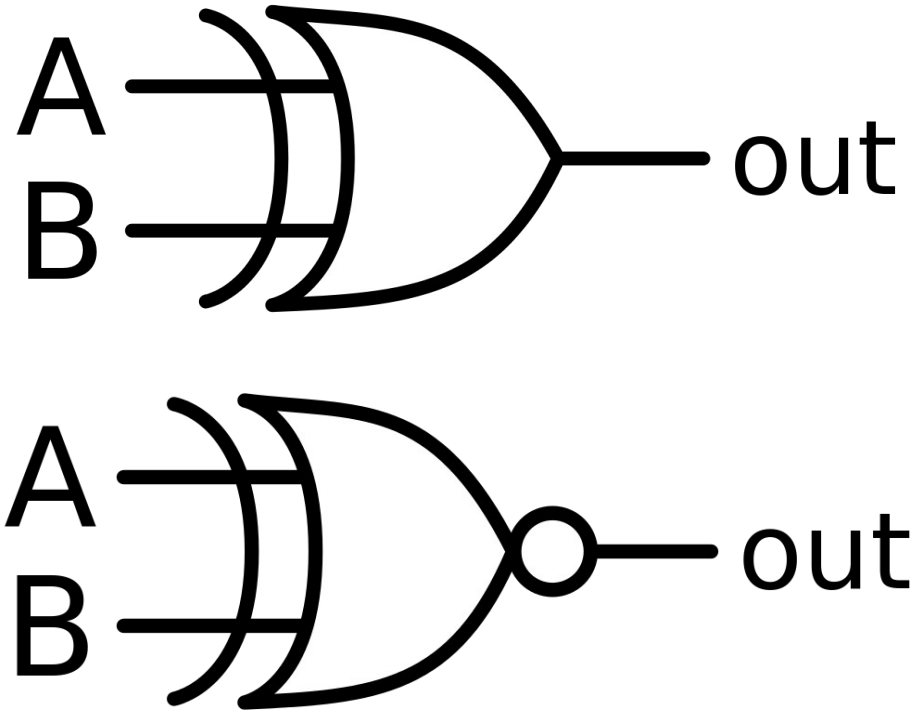
XOR(Either)

"One or the other of two; it does not matter which"[1]

I bought **either apple or banana** from market

*Not both and not none of them

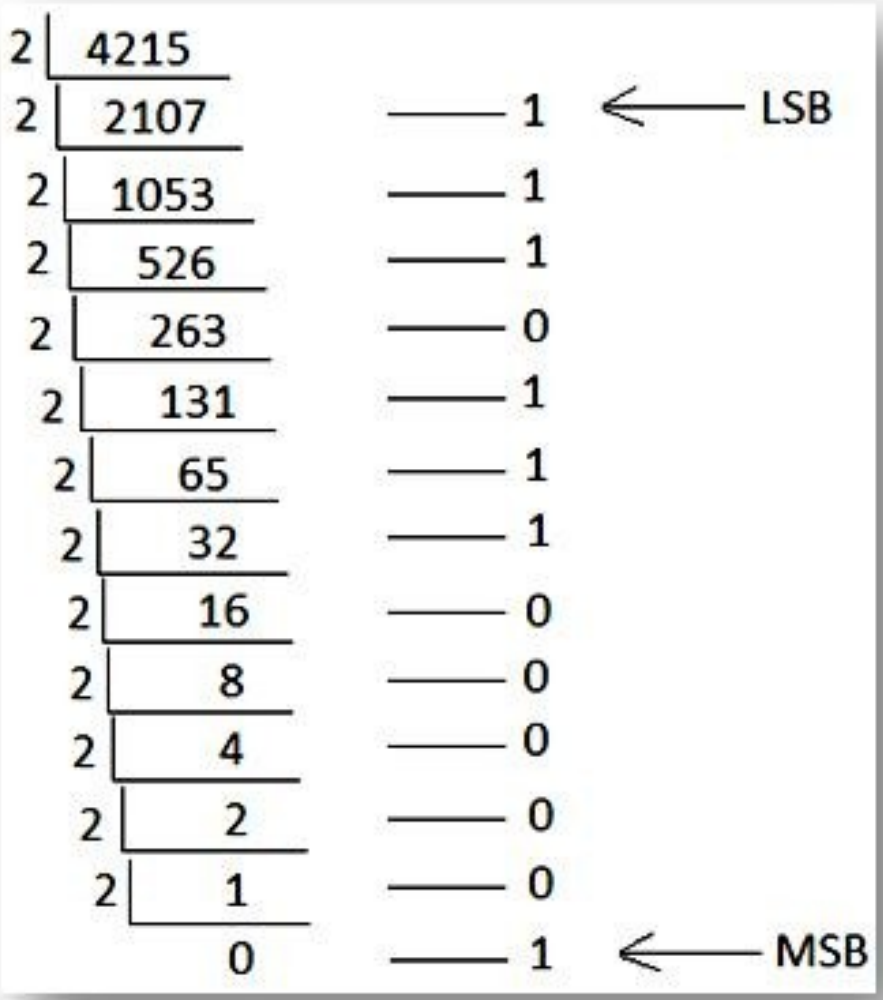
A	B	A⊕B
1	1	0
1	0	1
0	1	1
0	0	0

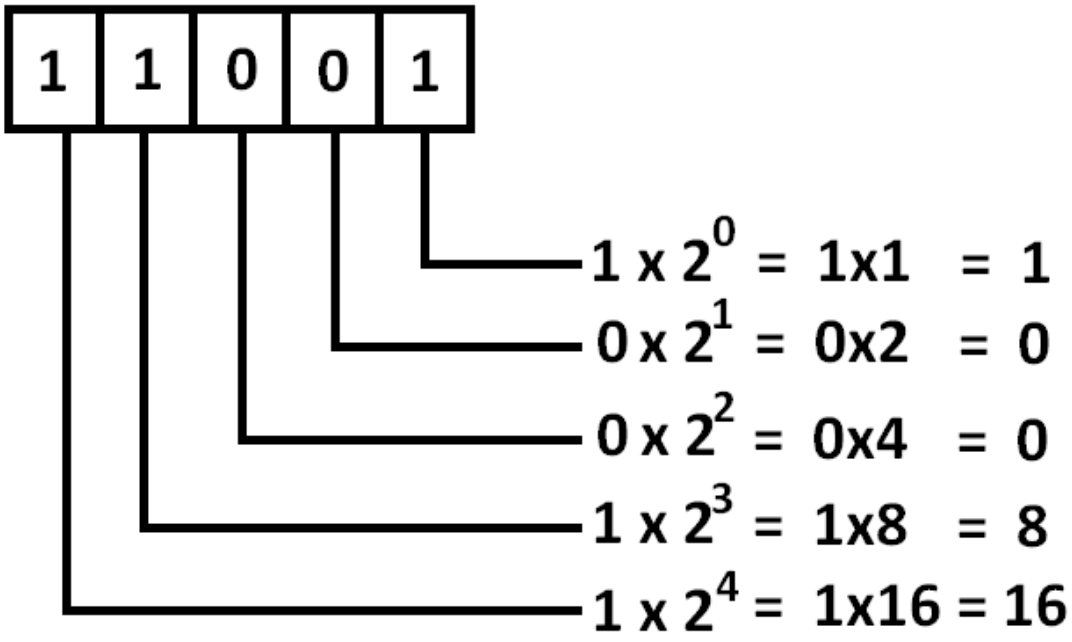


What Is Arithmetic?

***"The type of mathematics that deals with the adding, multiplying, etc. of numbers."*[1]**

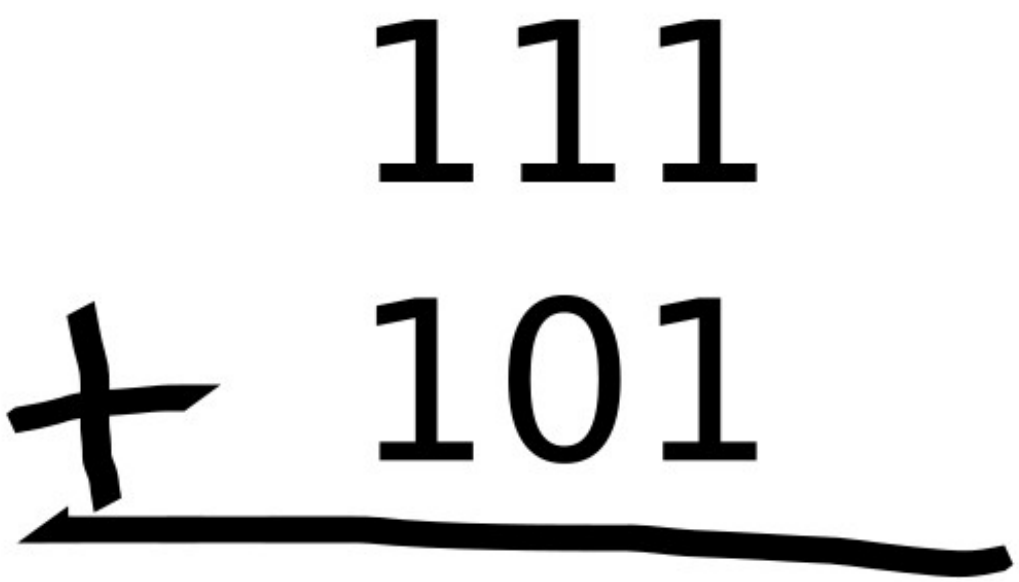
Expressing Numbers in Binary



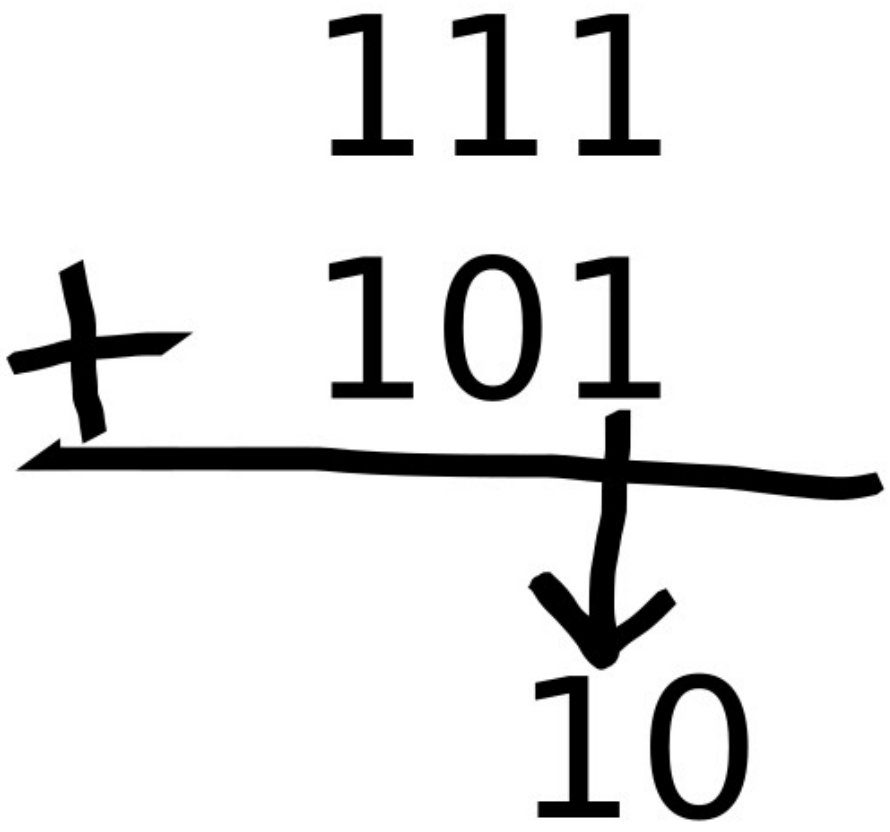


1 + 0 + 0 + 8 + 16 = 25 (Base 10)

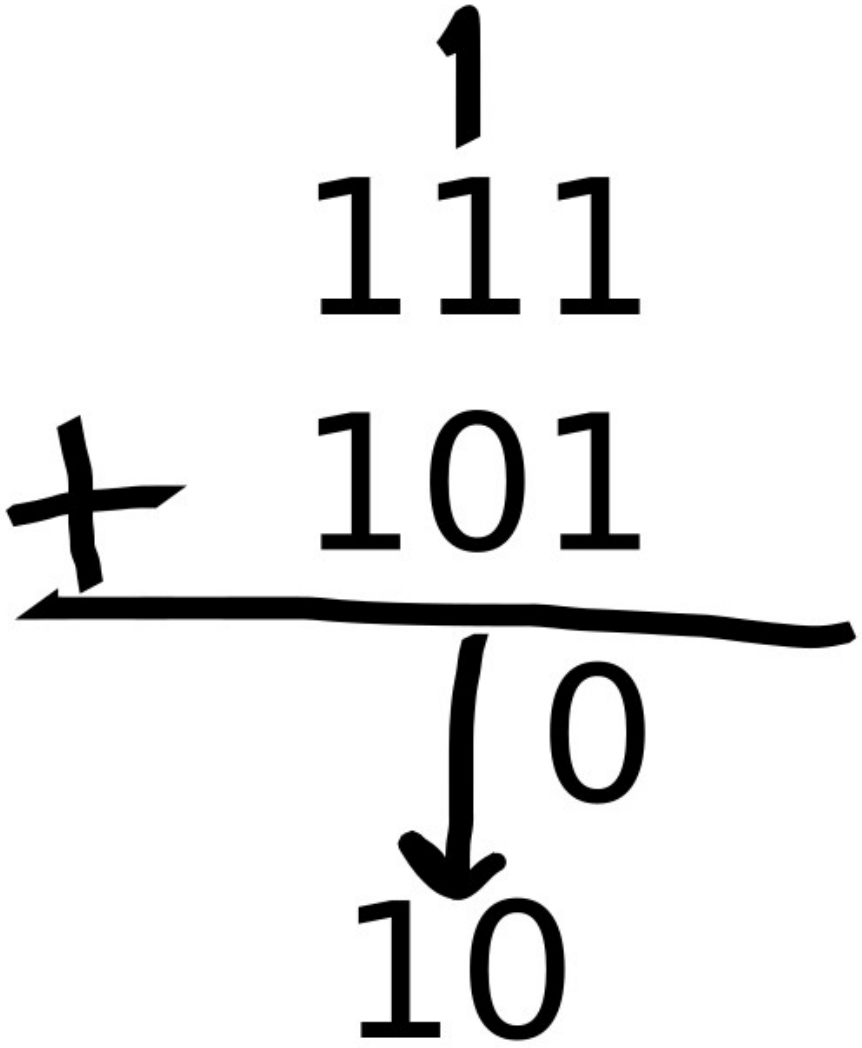
Addition



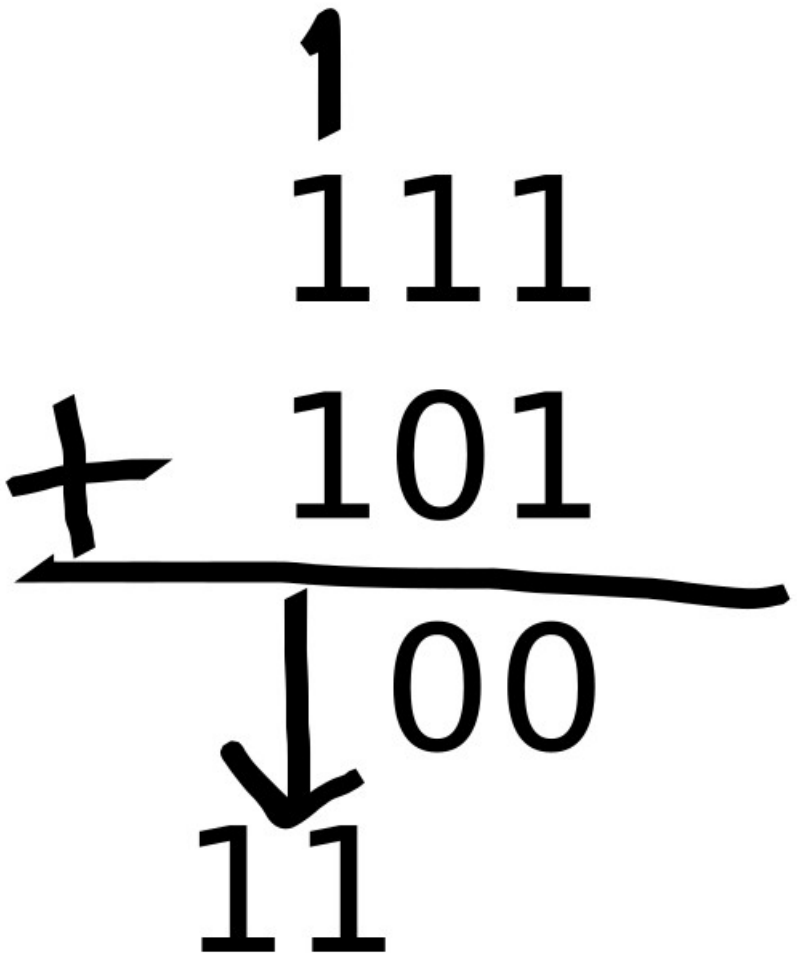
Addition



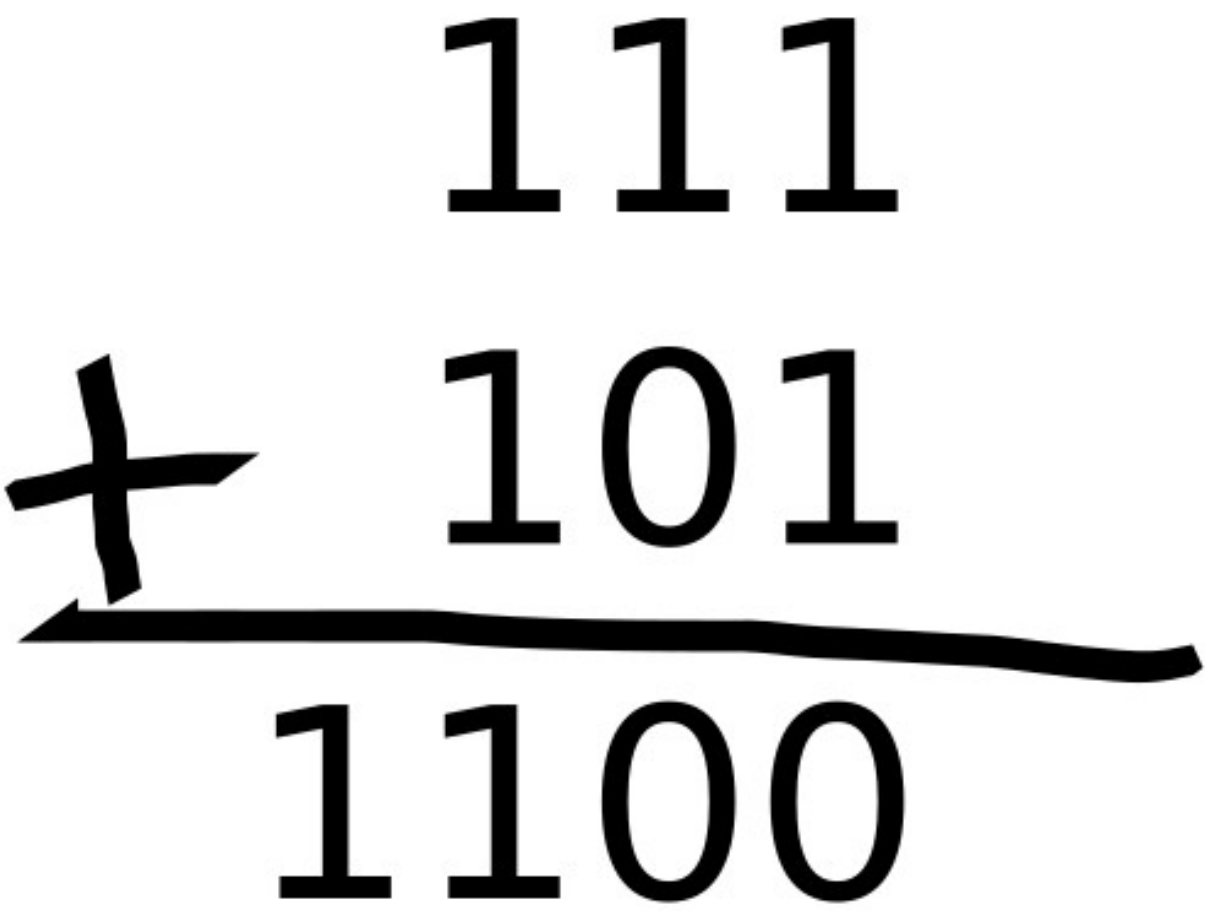
Addition



Addition



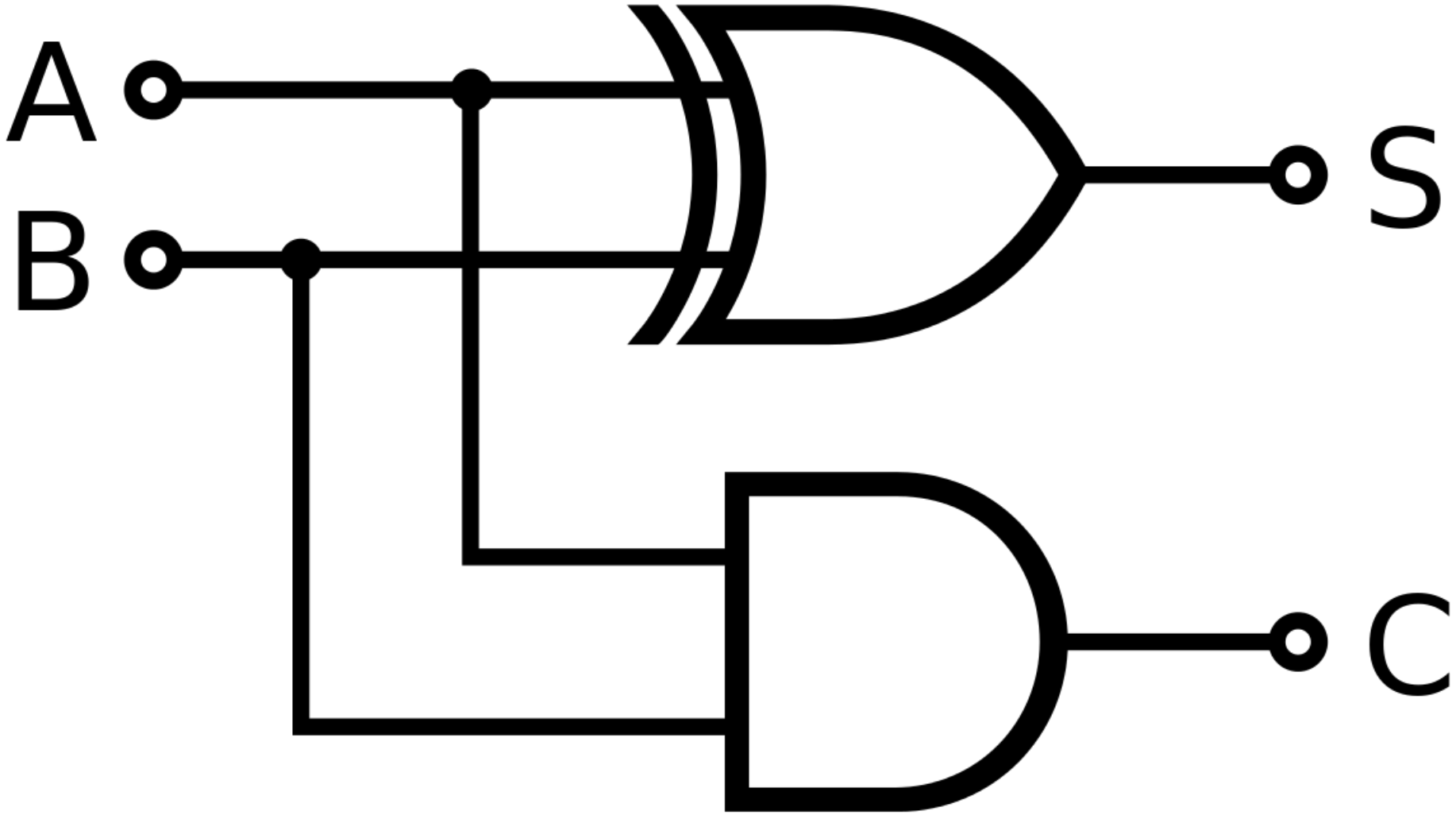
Addition



Addition

A	B	Carry	Sum
1	1	1	0
1	0	0	1
0	1	0	1
0	0	0	0

Half Adder



What If We Add Carry?

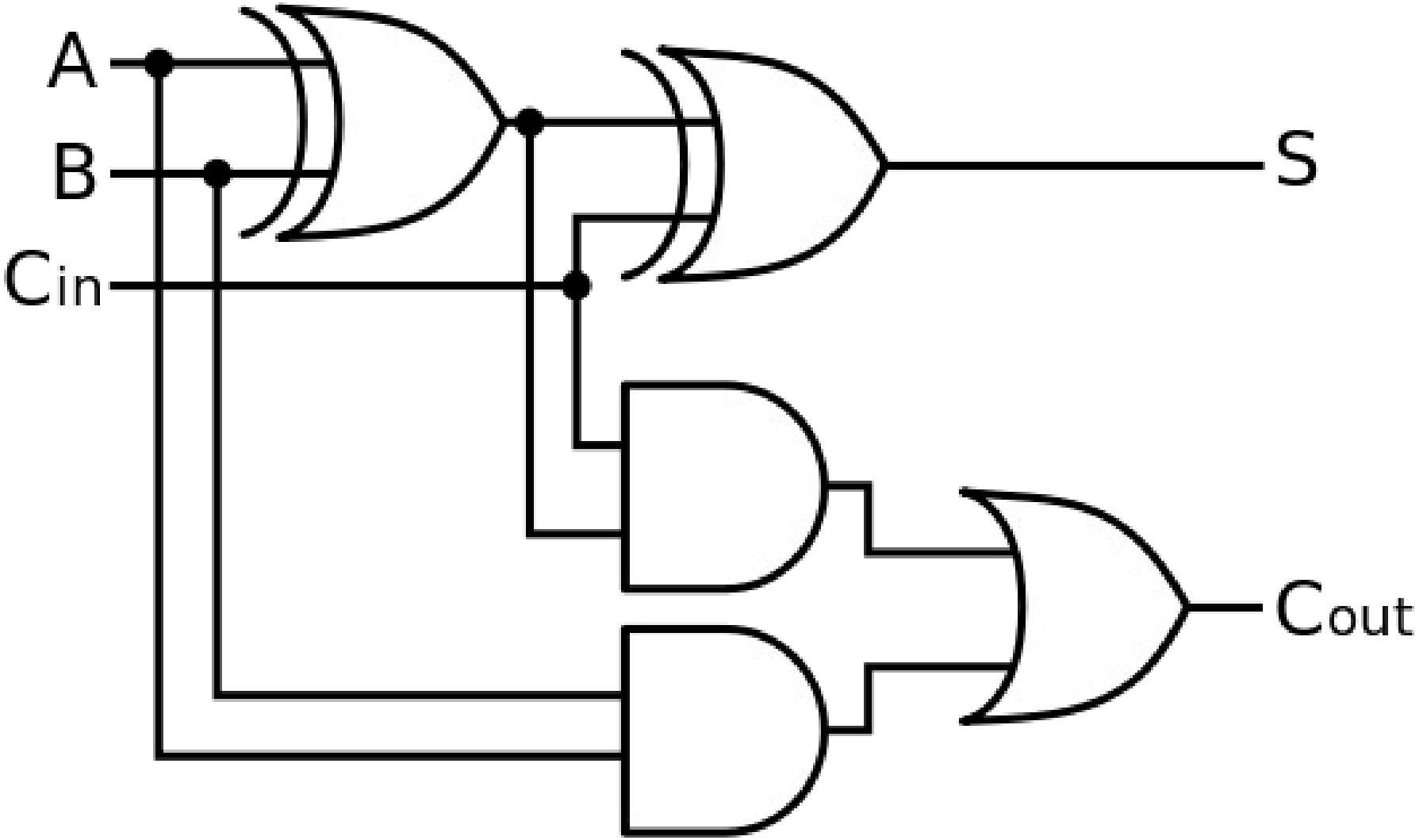
We will no longer perform A+B+Carry operation with 2 inputs.

We need a new circuit for adding three addend

Full Adder

A	B	C_{in}	C_{out}	Sum
0	0	0	0	0
0	0	1	0	1
0	1	0	0	1
0	1	1	1	0
1	0	0	0	1
1	0	1	1	0
1	1	0	1	0
1	1	1	1	1

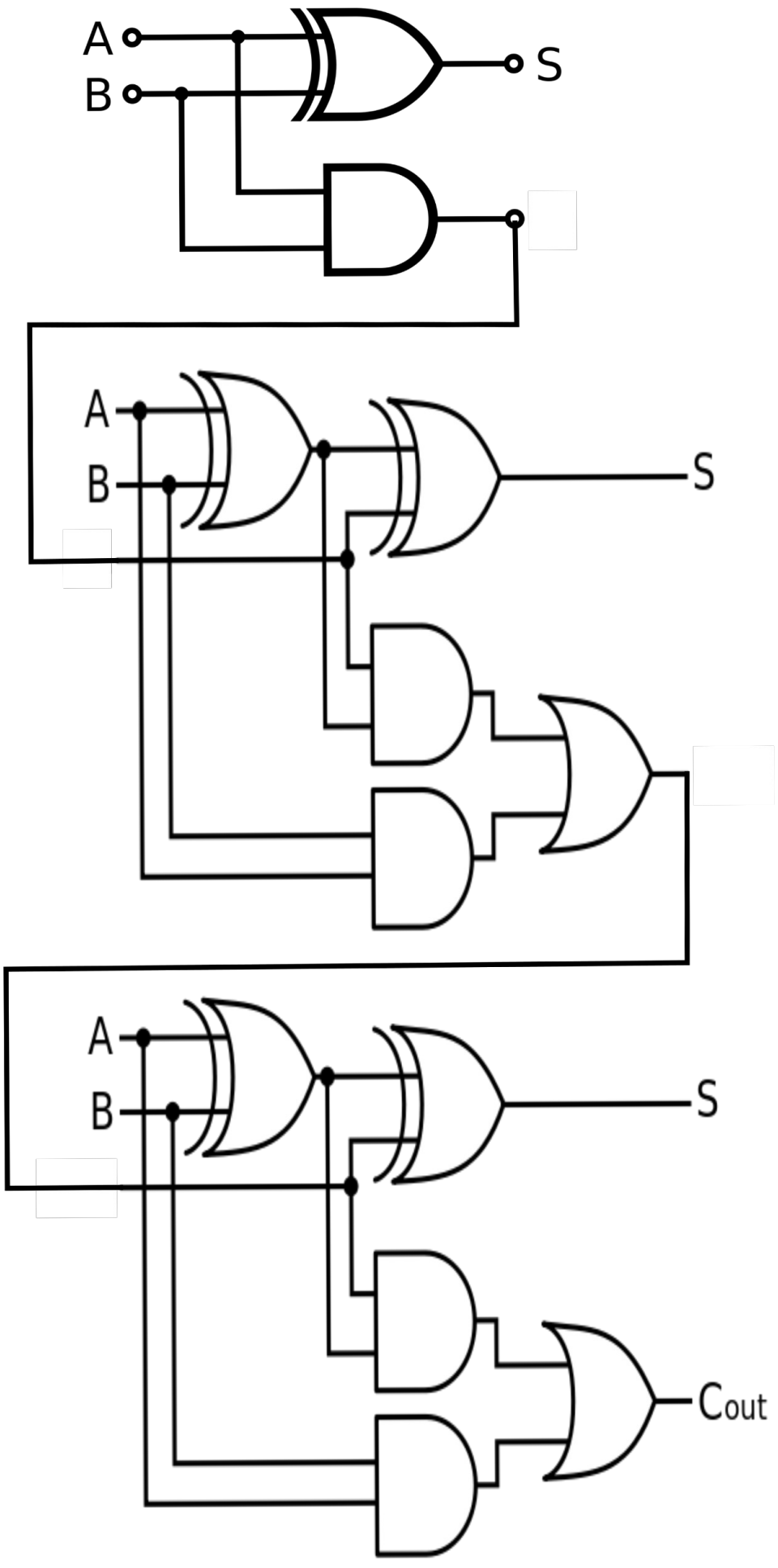
Full Adder



0

1

2



0

1

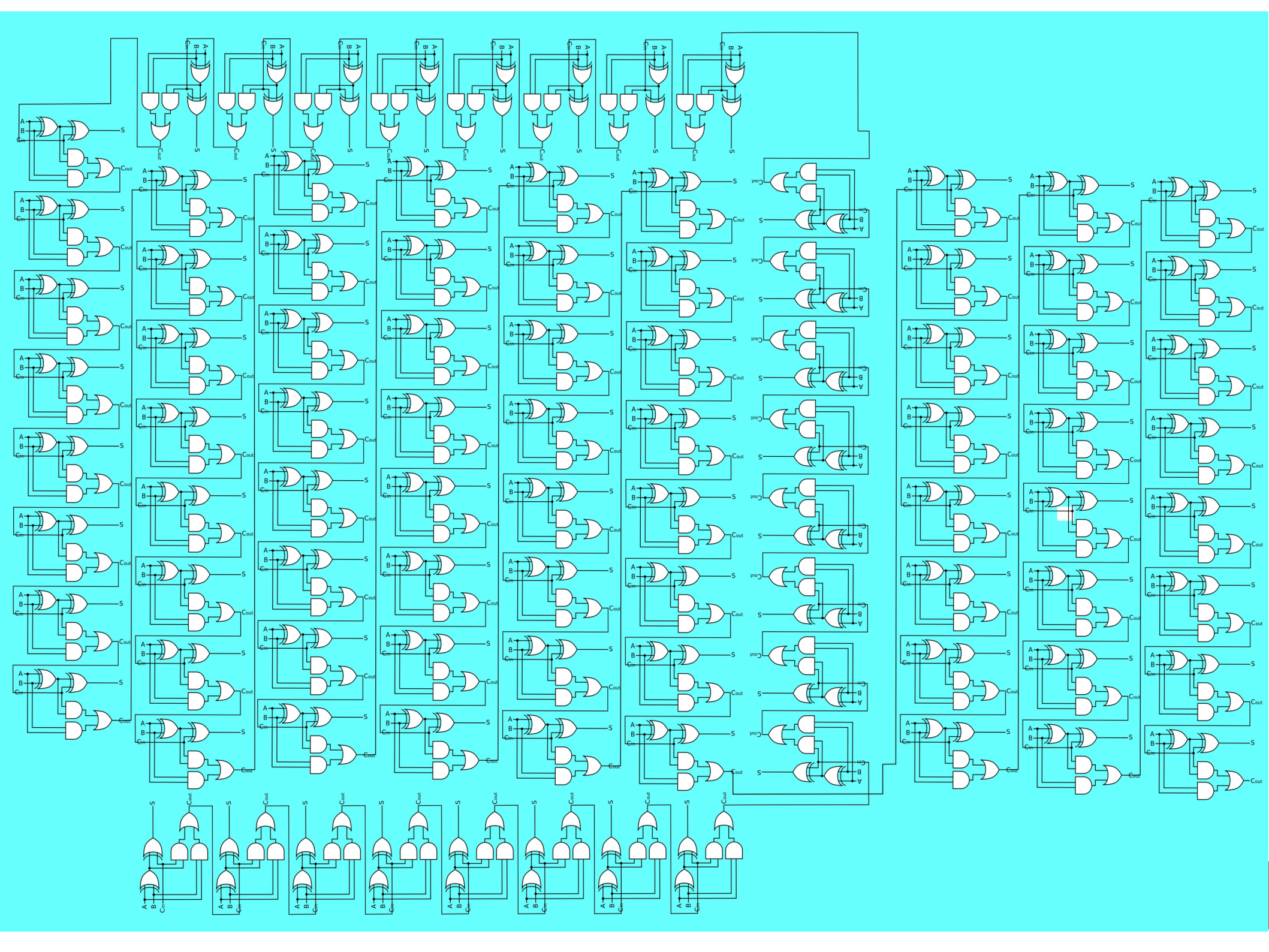
2

3

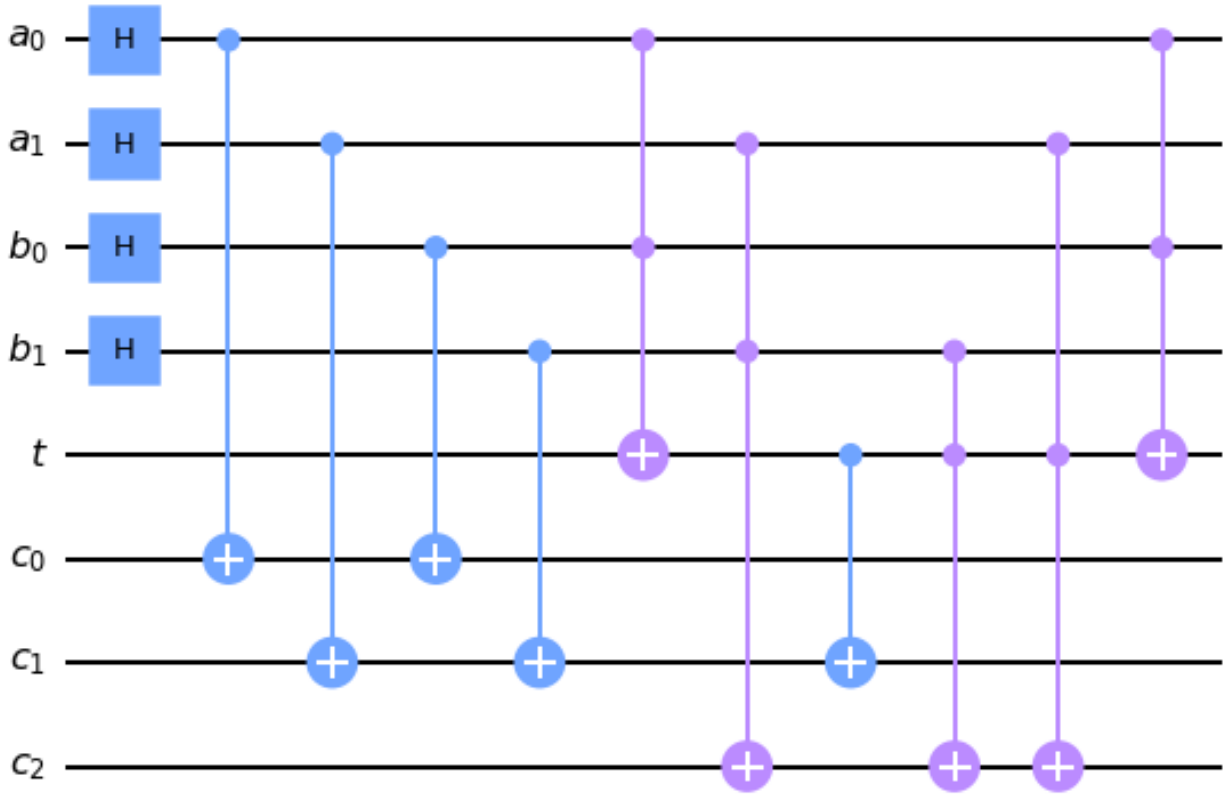
Using Quantum Mechanics

Quantum mechanics accelerates addition insanely.

We are able to perform 64 summing operations in the same instance if we use previous adder circuit .


A
B
Cin
S
Cout

Quantum Adder




```
0=0+0 00000-0000-0000
0=1+3 00000-0001-0011
0=3+1 00000-0011-0001
1=0+1 00001-0000-0001
1=1+0 00001-0001-0000
2=0+2 00010-0000-0010
2=1+1 00010-0001-0001
2=2+0 00010-0010-0000
3=0+3 00011-0000-0011
3=1+2 00011-0001-0010
3=2+1 00011-0010-0001
3=3+0 00011-0011-0000
4=2+2 00100-0010-0010
5=2+3 00101-0010-0011
5=3+2 00101-0011-0010
6=3+3 00110-0011-0011
16
```

References

[1] OxfordLearningDictionaries,viewed 21 Oct 2021 ,< https://www.oxfordlearnersdictionaries.com/ >

Thank you for your time