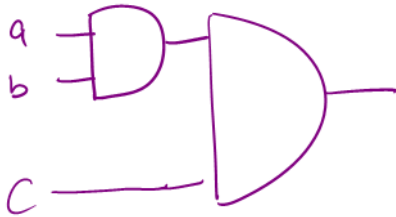


Computer Systems and Organization 1

Warm up!

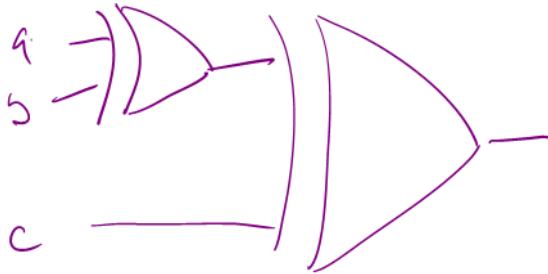
Can I ~~build~~^{make} an n -input AND
from 2-input AND gates?

$n=3$



Warm up!

What about XOR gates?



Adder, Clocks

CS 2130: Computer Systems and Organization 1

September 9, 2022

Announcements

- Quiz 2 out at 5pm, due Monday at 8am
- Homework 1 due Monday
- New Location! **Gilmer 301** on Monday **It's official!**

Review

- Transistors
- Information modeled by voltage through wires (1 vs 0)

• Gates

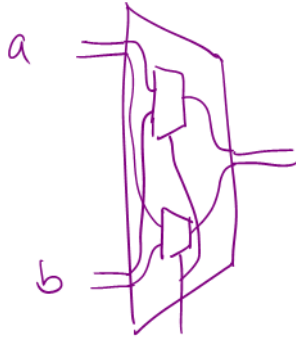


- Examples of AND, NOT gates
- Multi-bit values: representing integers
 - Signed and unsigned
- Floating point

How to do the work of multi-bit?

Multi-bit Mux

Our first multi-bit example: mux

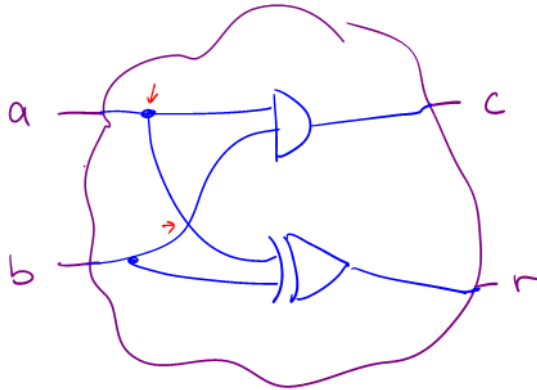


Adder

Add 2 1-bit numbers: a, b

$$\begin{array}{r} a \\ + b \\ \hline c \quad r \end{array}$$

a	b	c	r
0	0	0	0
0	1	0	1
1	0	0	1
1	1	1	0



Adder

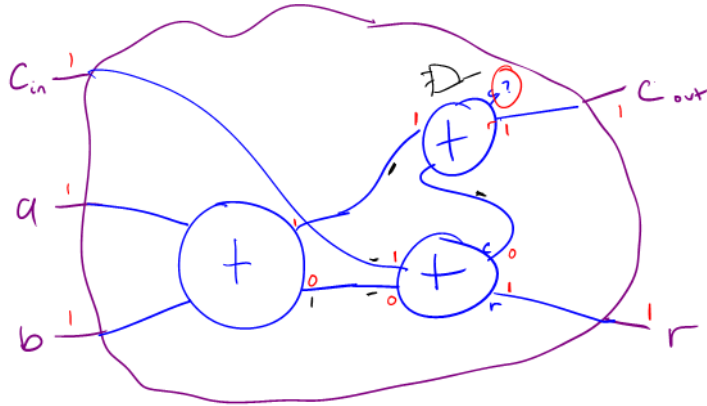
What is missing? Consider:

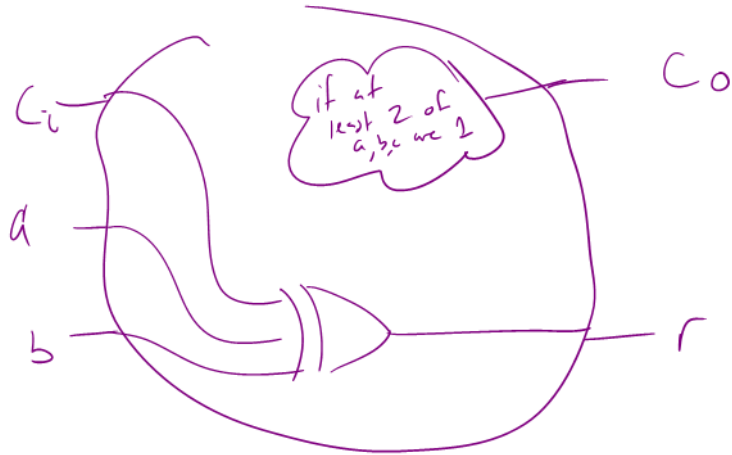
A handwritten diagram of a 2-bit adder circuit. The circuit is represented as a vertical rectangle with a horizontal line at the bottom. Inside the rectangle, the inputs are labeled '1 1' and '+ 0 1'. The output is labeled '1 0 0'. A purple arrow points to the top of the rectangle, and the text '3 things!' is written next to it. The output '1 0 0' has a double underline under the final '0'.

$$\begin{array}{r} \boxed{\begin{array}{r} \underline{1} \\ 1\ 1 \\ +\ 0\ 1 \\ \hline 1\ 0\ \underline{\underline{0}} \end{array}} \end{array} \quad \begin{array}{l} \text{3 things!} \\ \swarrow \end{array}$$

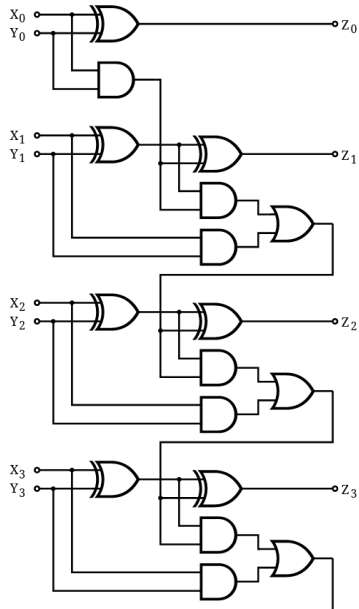
3-input Adder

Add 3 1-bit numbers: a, b, c

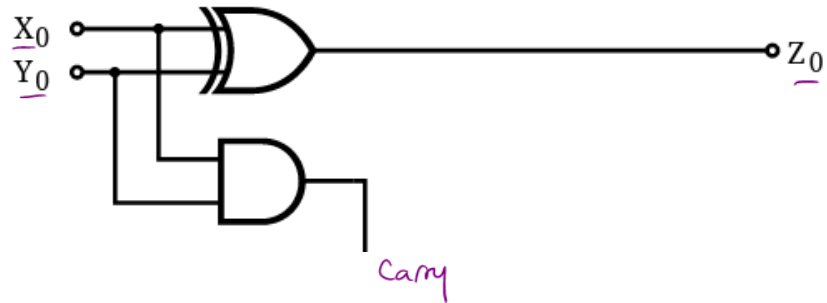




Ripple-Carry Adder

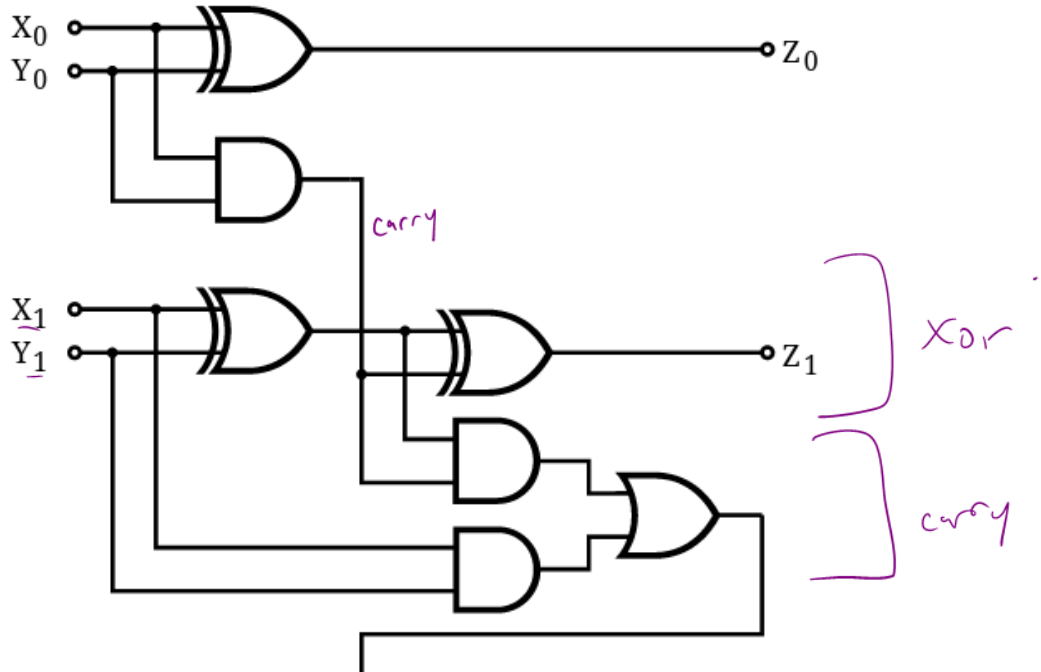


Ripple-Carry Adder

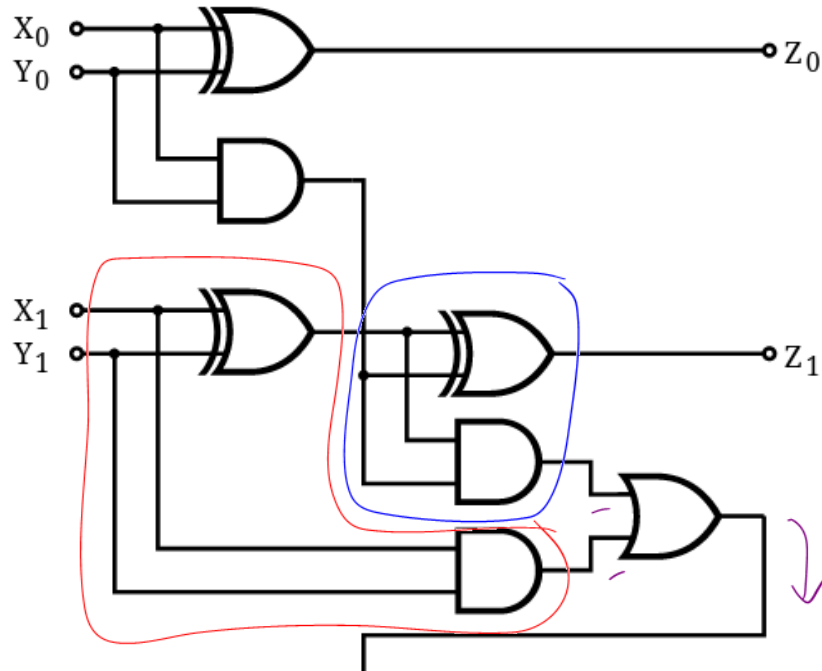


Ripple-Carry Adder

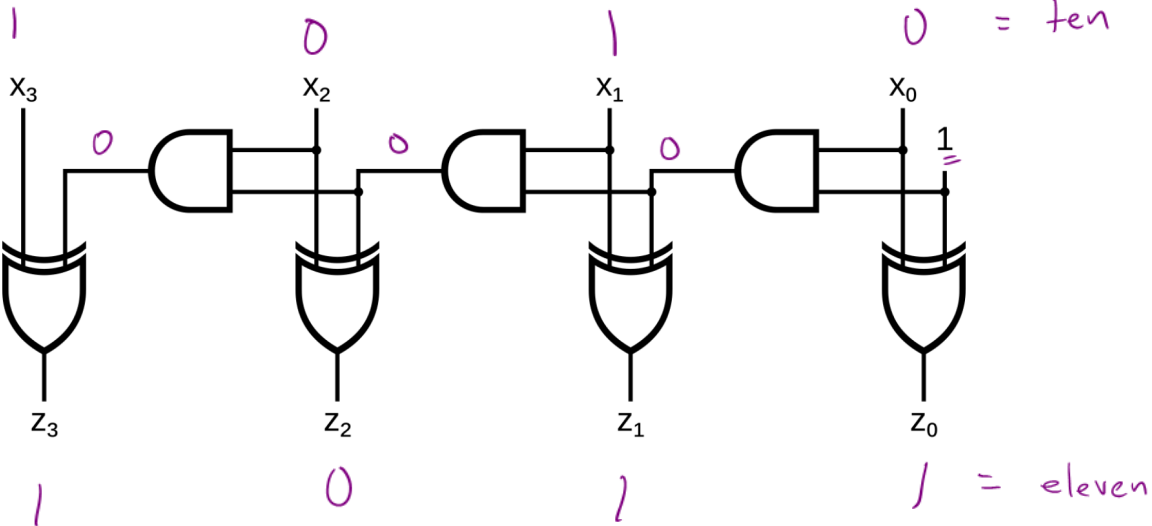
X_3, Y_2, X_1, X_0
↓



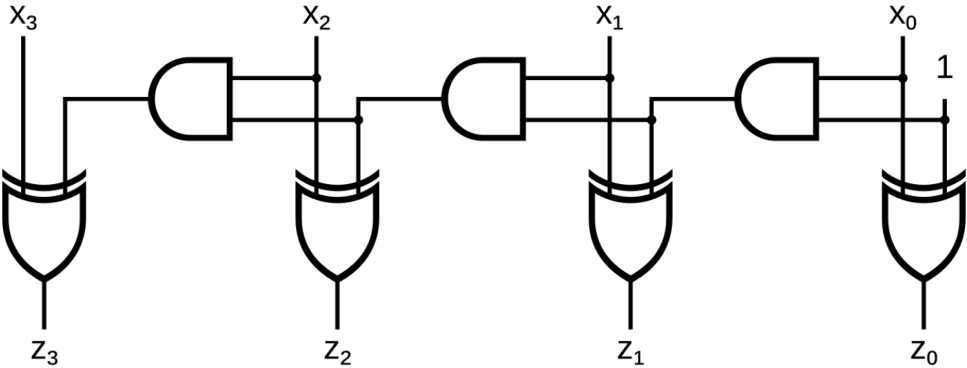
Ripple-Carry Adder



What does this circuit do?

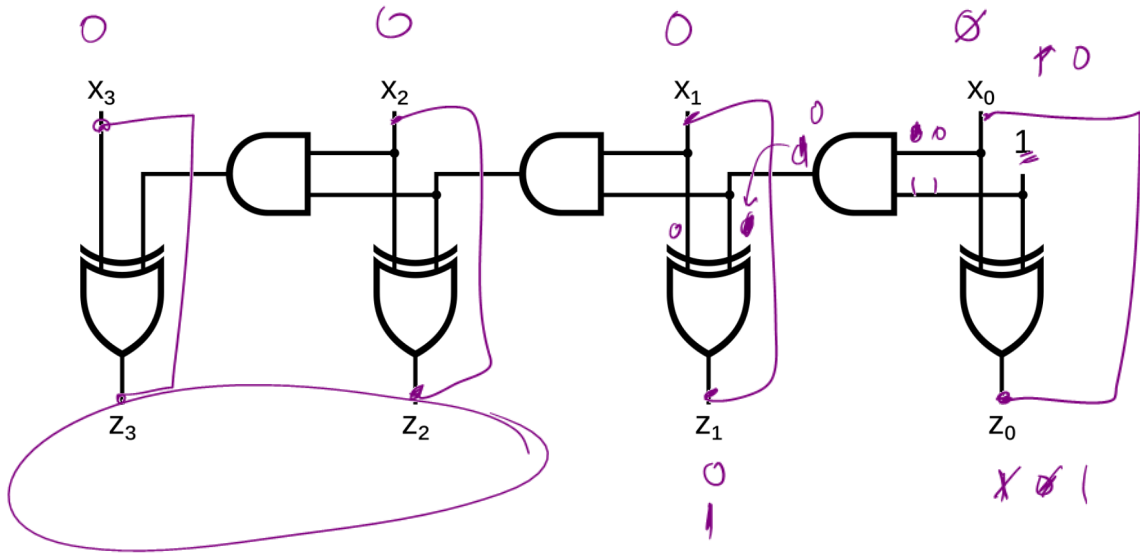


What does this circuit do?

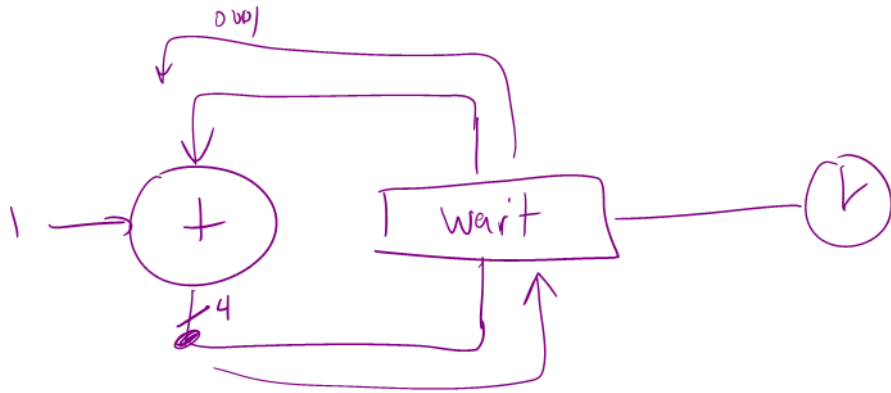


Increment Circuit

0000
0001
0010
0011



Building a Counter



Gate Delay

What happens when I change my input?

