Binary Arithmetic

CS 2130: Computer Systems and Organization 1

August 29, 2022

Course Content

Where do I go to find course material?

- Collab: central hub for 2130 this semester
  - Course website for all content
  - Lecture recordings on Panopto
  - Q&A discussion on Piazza
  - Submit assignments through Gradescope
- Community and online TA office hours on Discord

Expectations and Evaluations

Covid-19 Policies

- Masks are always welcome in class (I will be wearing one)
- No eating or drinking in the classroom
- Attendance is **not** required, but engagement is
  - Watch lecture videos
- If you don't feel well, stay home, it will be okay
  - Will work with you–if you stay home–to ensure no effect to grade

This is a Large Class

How can you get your questions answered?

- Piazza (!!)
  - If you know an answer to someone else's question, answer it!
  - We're in it together for the semester
- Discord
- TAs (office hours and labs)
- My office hours

Speaking of Office Hours!

TA Office Hours

- In-person office hours in the evening
- Online office hours throughout the day
- More information on Wednesday!

Office Hour poll

Professor Hott

Who am I? Why teach 2130?

Professor Hott

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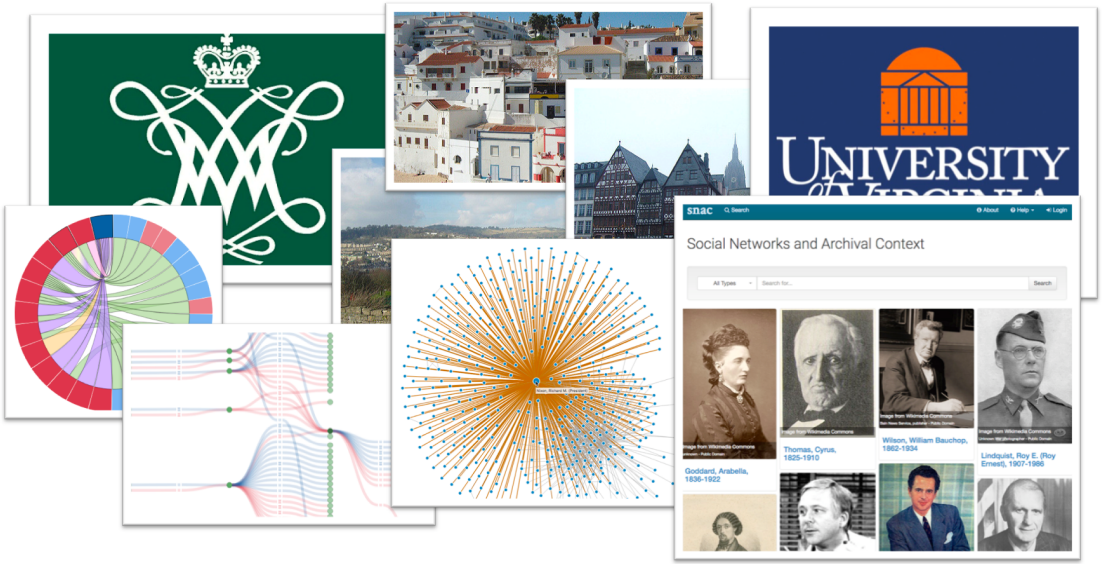

Questions?

So far...

So far, we have discussed:

- `and`, `or`, `not`, 0 and 1

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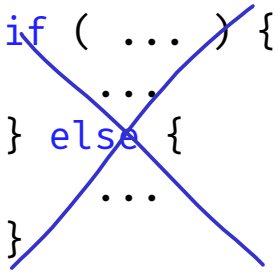
Now let's build something powerful

Trinary Operator

General idea



Trinary operator

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General idea

```
if ( ... ) {
    ...
} else {
    ...
}
```

Trinary operator

- Python: `x = b if a else c`

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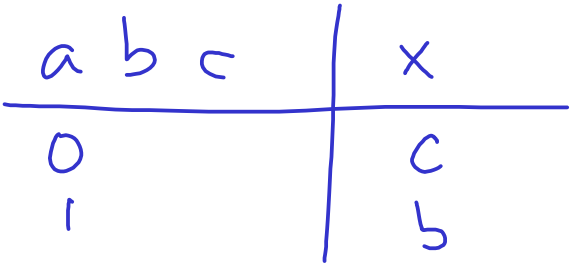
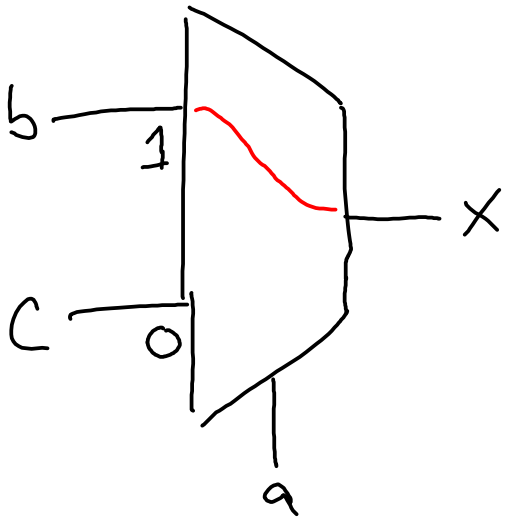


Trinary operator

- Python: `x = b if a else c`
- Java: `x = a ? b : c`

Multiplexer (mux)

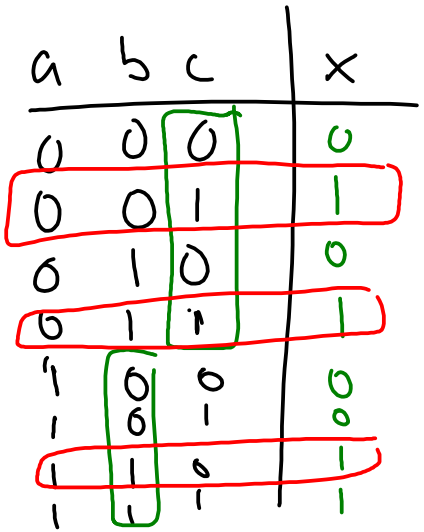
```
x = a ? b : c
```



Multiplexer (mux)

How can we build a mux out of what we have learned so far?

```
x = a ? b : c
```




```
(!a & !b & c) |
(!a & b & c) |
(a & b & !c) |
(a & b & c)
```

Multiplexer (mux)

Can be built from `and`, `or`, and `not`

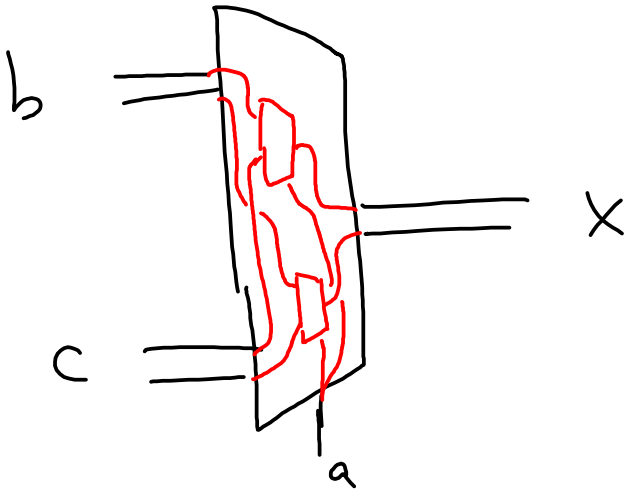
- Can be built using transistors
- Can physically put it in silicon!

Questions?

More bits!

2-bit Multiplexer (mux)

2-bit values instead of 1-bit values

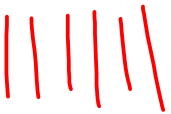


Multi-bit Values

- So far, only talking about 2 things
- Numbers, strings, objects, ...

Numbers

From our oldest cultures, how do we mark numbers?



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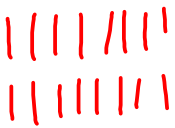

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- Update: group them!
- Romans used new symbols: V L C D M

Numbers

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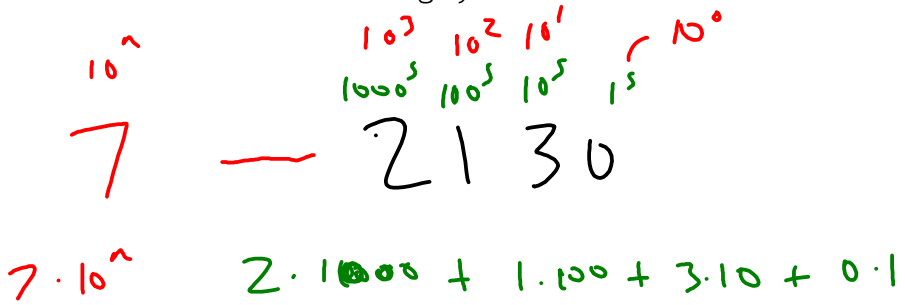
- Arabic numerals
  - Positional numbering system



0 1 2 3 4 5 6 7 8 9

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From our oldest cultures, how do we mark numbers?

- Arabic numerals
  - Positional numbering system
  - The `10` is significant:
    - 10 symbols, using 10 as base of exponent
  - The `10` is *arbitrary*
  - We can use other bases! $\pi, 2130, 2, \ldots$

Base-8 Example

Try to turn 134_8 into base-10: