CSC258: Computer Organization

Welcome to the class!

Today's Agenda

- Numeric Representations
 - How many ways can you represent 12?
- Introduction to Logic Gates
 - Why do we use binary logic?

Administrivia

Which of the following are a representation of the number 12? Explain your answer.

- $1. \ 1100$
- $2. \ 0011$
- 3. 00000 10100
- 4. The fingers on three hands.

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- 5. A foot.
- 7. C
- 8. 14
- 9. The number of eggs in a single, typical carton.
- 10. A circle containing an arrow pointing up.

Takeaways

 A symbol doesn't mean something unless we agree it means something.

- A representation has strengths and weaknesses.
 - Pick the appropriate representation for the job.
 - Use hexadecimal to represent addresses.
 - Use 2's complement for binary arithmetic!

Why Use Binary?

 To perform computation, we need a closed system (one that can regulate itself) that can execute a model that we can easily program.

- We've invested a huge amount of effort in finding physical devices that can "execute":
 - Storing data
 - Performing basic computations
- The best devices we've found so far are binary devices.

Task: 2's complement

 Draw a table that shows the representations and decimal values of all of the 3-bit 2's complement numbers.

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 Draw a table that shows the representations and decimal values of all of the 3-bit 2's complement numbers.

2. Add the following 2's complement numbers. Is there an overflow?
011 + 101

Boolean Logic: a Convenient Abstraction

- Computer science is a series of abstractions.
- We don't want to think about hardware restrictions while we solve programming problems, so we quickly move to a mathematical model.

- Boolean logic lets us define functions on (binary) values.
- We will build larger abstractions on top of this base.

```
# Assume m is previously defined
count, n = 0, 1
while n < m:
    if m % n == 0:
        count = count + 1
        n = n + 1
```

- Draw a flowchart of the code above.
- Then, identify the different elements in the flowchart. How many unique elements can you identify?

Takeaways

 High-level code can be viewed as a composition of smaller operations.

- At one level: assignment, conditional (branch), join
- At another level: <, %, +, ...

• We need a way to implement these operations in hardware!

Intro to Logic Gates

- Digital logic gates form the basis for all implemented computing machines.
- Basic gates:
 - AND
 - OR
 - NOT
 - NAND
 - NOR
 - XOR
 - XNOR
- Relationships between inputs and outputs are outlined in truth tables

Task: Build a Truth Table

I. Draw the truth table and symbol for a two-input XOR

Task: Build a Truth Table

 Draw the truth table and symbol for a two-input XOR

2. Draw the truth table for $(x \oplus y) + z$

Looking Ahead ...

Boolean Logic

- Gates are a physical representation of boolean logic
- Can convert between a circuit and a logic expression
 - Order of operations is important



Converting from Logic to Circuit

Step I: Group terms

 $f = ((\neg x_1) \cdot x_2) + (x_1 \cdot (\neg x_2))$

Step 2: Draw left to right from the innermost terms



Administrivia

Marking Scheme

Component	Weight	Description
Reading Quizzes	10 x 3%	10 minutes quizzes at the beginning of lab each week. There will be 11 (allowing you to miss 1 without without losing marks).
Labs	10 x 2%	Practical assignments performed in the lab each week.
Final Exam	50%	3-hours, based on the quizzes and practical assignments. You must earn a 40% to pass the course.

A Typical Week

- Review the reading guide, then work on exercises before class.
- Attend the class meeting, bringing your questions from the reading, and work on exercises with peers to build connections between the material.
- Prepare for the lab by reading the handout and getting started.
- Attend the lab to take the quiz and complete the lab.
- Review the reading guide exercises to see if there is anything that needs more work.

Your Tasks This Week

- Review for the quiz on Wednesday/Thursday
- Prepare for the lab by reading the handout. (You should be able to get the entire lab done in the lab this week.)
- Double-check the reading guide for this week, and then use next week's reading guide (posted Wedish) to prepare for next week.

Discussion Board

• ... we are currently discussion board-less.

- I am hoping to trial a new board, based on Discourse, that may improve the experience.
- If we don't get an instance of that board by Wednesday, I'll get us an instance set up on mybb.