Clarifications

- All slides will be posted online
- You can listen to the audio via the website or you can subscribe using iTunes
- Clicker grading
- Registering your clickers
Clicker Questions

- Not punishing for coming to class
- Each lecture is 10 points total
- If you answer in class, the minimum you can get is 8, the maximum is 10
- If you answer online, the minimum you can get is 0, the maximum is 8
Lecture 1 Review

- Barcode Check Digit
- Functional Abstraction
Check Digit

1. Add the digits in the odd-numbered positions (first, third, fifth, etc.) together and multiply by three.

2. Add the digits in the even-numbered positions (second, fourth, sixth, etc.) to the result.

3. Subtract the result from the next-higher multiple of ten. The result is the check digit.
Abstraction

Skin Cream

30521004300

305210043008

101 0111101001101101101001101100110011001001100110010001101 01010 11001010111001000100010111001011100101001000 101
Preface:

Magic in the Stone

CS105: Great Insights in Computer Science
Xbox Chip Layout
Computer Design

• Computers have billions of parts.
• Repeated patterns (hierarchy / reduction) make it simple!
• Ideas transcend technology.
Chapter 1: Nuts and Bolts

CS105: Great Insights in Computer Science
The Lowly Bit

- Chemistry has its molecules.
- Physics has its elementary particles.
- Math has its sets. \( \mathbb{N}_i := \{1, 2, \ldots, i\} \subset \mathbb{N} \)
- Computer science has its bits.
- They are the smallest unit of information.
  - True (1, on)
  - False (0, off)
What’s a “Bit”?

• Like “ginormous” (gigantic + enormous) or “motel” (motor + hotel); it is a *portmanteau*. More?

• It’s a contraction of “binary digit”, used by Claude Shannon, attributed to John Tukey.

• In our decimal (base ten) number system, a digit can be any of the ten values 0,...,9.

• In the binary (base 2) number system, a digit can be any of the two values 0 or 1.
Why a Bit?

- Bits have the property of being...
  - **simple**: There’s no smaller discrete distinction to be made.
  - **powerful**: Sequences of bits can represent seemingly anything!
Nearly everything has gone digital.

Digital sound: groups of bits represent the acoustic intensity at discrete time points.

Digital images: groups of bits represent the color at each particular discrete image location: pixel.
“Regular” Algebra

- Variables stand for numbers.
  - \( x = 3, \ p = \frac{22}{7}, \ a = -2 \)

- Binary operations (two numbers in, one out)
  - addition: \( 2 + 3 = 5 \); subtraction: \( 1 - 4 = -3 \)
  - multiplication: \( \frac{2}{3} \times \frac{7}{4} = \frac{7}{6} \)

- Unary operations (one number in, one out)
  - negation: \( -(11) = -11 \), square root: \( \sqrt{16} = 4 \)
Boolean Algebra

- Variables stand for bits (True/False).
  - $x = \text{True}, \ p = \text{False}$
- Binary operations (two bits in, one out)
  - and ("conjunction"): True and False = False
  - or ("disjunction"): True or False = True
- Unary operations (one number in, one out)
  - not ("negation"): not (False) = True
Follow the Rules #1

- When is it ok to be in an R movie? You are older than 16 or you have an adult guardian with you.

- $x$: Person is older than 16.

- $y$: Person is accompanied by an adult guardian.

- $x$ or $y$: Person can see an R-rated movie.
“OR” Examples

• Bill is 22 and is seeing the movie with his stepdad.
  • $x = True, y = True, x \text{ or } y = True$

• Samantha is 17 and is seeing the movie alone.
  • $x = True, y = False, x \text{ or } y = True$

• Seth is 16 and is there with both of his parents.
  • $x = False, y = True, x \text{ or } y = True$

• Jessica is 13 and is there with friends from school.
  • $x = False, y = False, x \text{ or } y = False$
Follow the Rules #2

All vehicles parked on University property must be registered and display a valid Rutgers permit.

• $x$: Car is registered.

• $y$: Car displays a valid Rutgers permit.

• $x$ and $y$: Car can be parked at Rutgers.
“AND” Examples

• Bill’s car is registered and displays a valid permit.
  • \( x = True, y = True, x \text{ and } y = True \)

• Samantha’s is registered, but the permit fell off.
  • \( x = True, y = False, x \text{ and } y = False \)

• Al’s registration expired, but his permit is still ok.
  • \( x = False, y = True, x \text{ and } y = False \)

• Jessica is visiting with no registration or permit.
  • \( x = False, y = False, x \text{ and } y = False \)
Follow the Rules #3

• It is not allowed by federal law to provide tobacco products to persons under 18 years of age.

• $x$: Person is under 18.

• not $x$: Person can buy tobacco
“NOT” Examples

• Samantha is 17 and is buying cigarettes.
  • $x = \text{True}$, not $x = \text{False}$

• Seth is 21 and purchased a cigar.
  • $x = \text{False}$, not $x = \text{True}$
And, Or, Not

- The most important logical operations are and, or, and not.
- \( x \text{ and } y \) is True only if both \( x \) and \( y \) are True.
- \( x \text{ or } y \) is True only if either \( x \) or \( y \) are True.
- \( \text{not } x \) is True only if \( x \) is False.
- A lot like their English meanings, but unambiguous.
Relating And/Or/Not

- **Note**: not (not $x$) = $x$
- **DeMorgan’s Law**: not flips ands and ors
  - not ($x$ and $y$) = (not $x$) or (not $y$)
  - not ($x$ or $y$) = (not $x$) and (not $y$)
DeMorgan’s Law Example

• $x$: Rob can juggle.

• $y$: Rob can ride a unicycle.

• not ($x$ and $y$): Rob is not a juggling unicycler. (It’s not the case that Rob can both juggle and ride a unicycle.)

Equivalently:

• (not $x$) or (not $y$): Either Rob can’t juggle or Rob can’t ride a unicycle. (Rob fails at at least one of those things.)
Implementing Logic

• Clearly, our brains can handle these sorts of expressions.

• But, can we automate them?

• Yes, obviously, but let’s start with a really simple way to do it before we move on to fancier stuff.
Simple Circuit

Switch A is either on or off making the light either on or off: \( \text{lightOn}=A \).

Symbols:
- battery
- switch
- bulb
- ground (completes circuit)

http://scratch.mit.edu/projects/cs105/35907
Multiple Switches

A = False

B = True

C = True

D = False

http://scratch.mit.edu/projects/cs105/35905

http://scratch.mit.edu/projects/cs105/35909
Multiple Switches

Switches A and B are wired in parallel: either will light the bulb.

A = False
B = True
C = True
D = False

http://scratch.mit.edu/projects/cs105/35909
http://scratch.mit.edu/projects/cs105/35905
Multiple Switches

Switches A and B are wired in parallel: either will light the bulb.

Switches C and D are wired in series: both are needed to light the bulb.

http://scratch.mit.edu/projects/cs105/35905

http://scratch.mit.edu/projects/cs105/35909
Special switches allow a single mechanical switch to control two circuits simultaneously.
Multiple Circuits

Special switches allow a single mechanical switch to control two circuits simultaneously.
Multiple Circuits

light1 = A or B

light2 = A and B

Special switches allow a single mechanical switch to control two circuits simultaneously.