Functions Review, Midterm Review, Steganography (hiding bits in bits)
For loops
Announcements

- Creative Assignment HW9
  Deadline extended due to popular demand
  Saturday Feb 11th, 5PM

- Will cover some stuff today and Thursday that might help you be more creative

- Midterm one week from today. Will cover all the material up through today.
HW9: Creativity in Processing

Assignment. Write four programs to do whatever you want (but don’t copy the examples above), and try to make them clever or interesting or cute or have some property that would interest a viewer. You should try to use those you have learned in your former Processing homework, because those are the basics and one goal of this assignment is to practice the basics. But, if you need some other feature of processing that you find in the reference page, go ahead and use it. The goal is creativity … but don’t spend forever on it either.
How is it going?
Functional Abstraction Reduces Complexity

Layering: Building Functions out of Functions
Functions, A Review

- Functions have been used in Lightbot 2.0: F1
- Functions were in Assignment 03: F.turn( ) ...
- We’ve used functions, also known as
  - procedures
  - methods
  - subroutines
in all of our Processing code: size(200, 200)
- Recall that functions have two parts:
  - function definition ... a statement of how it works
  - function call ... a request to have it performed
Functions In Processing

- Form of function definition in Processing
  
  `<return type> <name> ( <param list> ) { 
    <body> 
  }`
  
  as in

  ```java
  void draw_a_box (int x_pos, int y_pos) {
    rect(x_pos, y_pos, 20, 20);
  }
  color pink ( ) {
  }
  or
  return color(255, 200, 200);
  ```
Functions In Processing: Result

- Functions that do something, but do not return a value, have **void** as their `<return type>`
- Functions that return a value must say its type

```cpp
void draw_a_box (int x_pos, int y_pos) {
    rect(x_pos, y_pos, 20, 20);
}

color pink () {
    return color(255, 200, 200);
}
```
Functions In Processing: Params

- Parameters are the values used as input to the function; parameters are not required, but the parentheses are.
- The type of each parameter must be given.

```java
void draw_a_box (int x_pos, int y_pos) {
    rect(x_pos, y_pos, 20, 20);
}

color pink ( ) {
    return color(255, 200, 200);
}
```
Functions In Processing: Return

- A function returns its value with the `return` statement ... the stuff following return is the result
- The function is done when it reaches return

```java
void draw_a_box (int x_pos, int y_pos) {
    rect(x_pos, y_pos, 20, 20);
}

color pink () {
    return color(255, 200, 200);
}
```
Writing Functions

- Processing function definitions are typically listed after the standard blocks: setup(), draw(), mousePressed(), etc.

```java
definition
void setup() {
  size(100, 100);
  background(0);
  noStroke();
}

definition
void draw() {
  fill(255);
  hexa(20, 20);
}

definition
void hexa(float xbase, float ybase) {
  rect(xbase, ybase+10, 20, 40);
  triangle(xbase, ybase+10, xbase+20, ybase+10, xbase+10, ybase);
  triangle(xbase, ybase+50, xbase+20, ybase+50, xbase+10, ybase+60);
}
```
Using Functions

- Once defined, functions can be called repeatedly ... it’s the point of writing them!

```c
void setup() {
    size(110, 100);
    background(0);
    noStroke();
}

void draw() {
    fill(255);
    hexa(20, 20);
    hexa(50, 20);
    hexa(80, 20);
}

void hexa(float xbase, float ybase) {
    rect(xbase, ybase+10, 20, 40);
    triangle(xbase, ybase+10, xbase+20, ybase+10, xbase+10, ybase);
    triangle(xbase, ybase+50, xbase+20, ybase+50, xbase+10, ybase+60);
}
```
Arguments Become Parameters

- Notice that if the DEFINITION has \( n \) parameters, the CALL needs \( n \) arguments
- The parameters and arguments correspond

Inside of the function, the parameter, e.g. \( x_{\text{base}} \), is declared and initialized to the corresponding argument, e.g. 80. Then, the definition uses it, e.g.

\[
\text{rect}(80, 40+10, 20, 40)
\]

```c
void draw() {
  fill(255);
  hexa(20, 40);
  hexa(50, 40);
  hexa(80, 40);
}

void hexa(float xbase, float ybase) {
  rect(xbase, ybase+10, 20, 40);
  triangle(xbase, ybase+10, xbase+20, ybase+10, xbase+10, ybase);
  triangle(xbase, ybase+50, xbase+20, ybase+50, xbase+10, ybase+60);
}
```
Parameters

- Parameters are automatically declared (and initialized) on a call, and remain in existence as long as the function remains unfinished.

- When the function ends, **the parameters vanish**, only to be recreated on the next call.

- It is wise to choose parameter names that help you remember exactly what they mean:
  - `colorFlag` (Chao’s code),
  - `dir` (for direction).

- I chose `xbase` as the orientation point of the figure in the x direction, I use that name a lot and I know what it means.
What will be on the midterm?
“Computing capacity is increasing at 58% annually, telecommunications at 28%, and storage at 23% per year. The former rate is approximately the rate of Moore’s Law, a doubling every 18 months. Communications are doubling every 34 months and storage every 40 months. Information has been expanding at this rate for the past decade.”
Increase of Computing Power

![Graph showing the increase of computing power over time with different metrics such as transistors, clock speed, power, and Perf/Clock (ILP). The graph indicates a significant increase from 1970 to 2010.]
Big Data is here

The World's Capacity to Store Information

This chart shows the world's growth in storage capacity for both analog data (books, newspapers, videotapes, etc.) and digital (CDs, DVDs, computer hard drives, smartphone drives, etc.).

In gigabytes or estimated equivalent:

- 1986: 2.62 billion
- 1993: 0.02 billion

Computing Power

In 1986, pocket calculators accounted for much of the world's data-processing power.

Percentage of available processing power by device:

- Pocket calculators
- Personal computers
- Video game consoles
- Servers, mainframes

- PCs: 44.5%
- 123 billion gigabytes
How big?

The full scale of how much information we make is hard to appreciate. We humans collectively now have capacity to store approximately 300 exabytes of information. This is close the total amount of information stored in one person’s DNA. Or, as Hilbert puts it, it’s the equivalent of 80 Library of Alexandrias per person on the planet. And remember, the technium is doubling its capacity every year and a half, and your DNA is not. Broadcasting has grown at about the same speed as world’s GDP; but our information storage capacity has grown 4 times faster and telecommunication capacity has grown roughly 5 times faster than the world’s economic power.
Assignments 1,2,3: Lightbot 2.0

- RECURSION
- FUNCTIONS
- FUNCTIONAL ABSTRACTION
How do Computers represent data?
The first electronic computers: codebreaking during WW II

- [http://www.youtube.com/watch?v=NbhbssXWDAE](http://www.youtube.com/watch?v=NbhbssXWDAE)
- COLOSSUS in the U.K.
- ENIAC at Penn
- Female mathematicians were the first programmers!
McCulloch and Pitts 1943

- “A Logical Calculus of the Ideas Immanent in Nervous Activity”
- Simple model of human brain, neuron
- Influenced the design of the first computers
- Starts with **Logic**
- Ideas from logicians: Carnap, Russell and Whitehead.
McCulloch Pitts Neuron for AND

\[ X + Y - 2 \]

\[ X \text{ AND } Y \]

\[ X \rightarrow +1 \]

\[ Y \rightarrow +1 \]

\[ I \rightarrow -2 \]
How the neuron computes logical AND

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<th>Output</th>
</tr>
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These are the fundamental units of computers.
These are the fundamental units of computers.
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**Example ASCII Representation:**

- **Binary:** `0100 0011` (H)
- **Binary:** `0100 0001` (O)
- **Binary:** `0101 0100` (C)

**Image:** A hand holding a yellow and black cat on a blue background.
With 8 places how many different letters?
UTF-8: All the alphabets in the world

- Uniform Transformation Format: a variable-width encoding that can represent every character in the Unicode Character set
- 1,112,064 of them!!!
- UTF-8 is the dominant character encoding for the World-Wide Web, accounting for more than half of all Web pages.
- The Internet Engineering Task Force (IETF) requires all Internet protocols to identify the encoding used for character data
- The supported character encodings must include UTF-8.
Key ideas from last time

- By 1943, it had been shown that computers could be used for…..???
  - **Counting, Arithmetic**
  - **Translation of language** (code breaking in WWII. BBC video)
  - **Logic.** McCulloch and Pitts, Neuron models for And/Or

- What are properties of the human brain that computers in general don’t have, but that the internet does?
  - Graceful degradation
  - Fault tolerance.

- Why does the brain and the internet have these properties? Redundancy, parallelism
Key ideas from last time

- Computational Thinking/programming:
  - Functional abstraction
  - Subroutine (F2 that does a part of the job)
  - Bottom up vs. top down programming

- Representation of data on computers:
  - Bits, bytes, ASCII, UTF
  - Presence or Absence of signal: PandA
  - Signal can be mechanical, electrical, color, light, blinking an eye, moving a finger, yes, no, true false
  - Hollerith tabulating machine: mechanical => electrical
Total Information Awareness

- [http://privacysos.org/tia](http://privacysos.org/tia)
Blown 2 Bits. Ch. 2. 1984 is here and we like it
What are you supposed to learn?

- What is a digital footprint?
- What technology advances in the last ten years have made ‘Big Brother’ possible
- Which organizations try to protect your privacy.
- Why you should read the “Terms and Conditions” for every app you download
  - You never know what they might say. Example: Pulse App asks you to give permission for them to track every number you call
- Why you should consider what you put onto public sites like Facebook.
  - Are you sure your privacy settings are as you want?
- Name three recent cases of information going viral that could never have happened ten years ago.
Total Information Awareness

- [http://privacysos.org/tia](http://privacysos.org/tia)
Total Information Awareness

- Pharmacy purchases
- Elementary school attendance records
- Doctors Visits

Application: School absences and pharmacy records could lead CDC to identify bioterrorism

Assistant to Poindexter: “We were surprised that privacy was an issue”

The government can’t collect this information but we can pay Johns Hopkins to do it. They have a medical school.
Google's New Privacy Definition.

Google's New Privacy Policy May Violate HIPAA, Congressman Says
2 at 8:55am ET by Matt McGee

Members of Congress continued to express concerns about Google's new privacy policy after a closed-door meeting on Thursday, with one House member saying the company's handling of sensitive medical searches may violate the Health Insurance Portability and Accountability Act.

The House Energy and Commerce committee held Chavez, Google's director of public policy, and former Michael Yang for about two hours. After the meeting, several of theatives expressed their unhappiness with Google's answers on a variety of questions brought on by Google's recent announcement that it will combine policies into one, which will allow the company to share user information across.

Joint, according to Representative Mary Bono Mack, might leave Google in violation of the law that protects how personal health information may be shared. Bono Mack her concerns to USA Today:

"you do a Google search for cervical cancer and you forget to sign out. Are you racked across all of the other products, and if so, that's a violation of HIPAA gone to great lengths in our society to protect people's medical information. I think was raised."

This is suggesting that Google might be violating HIPAA if it remembers the "search after the user moves on from search to another Google product, like G (or any other)."

- WHAT IS GOOGLE’S AIM?
- ADVERTISING!!!
- WHY IS FACEBOOK’S VALUATION SO HIGH?
- ADVERTISING!!!
Dear Marilyn,

Americans across the nation today are writing and calling their members of Congress with a simple request: Stop Internet companies from secretly tracking children online!

If you can lend your voice to this important national effort, take a moment to send an email now. If you can do more, forward this email to five of your friends and family so they can speak out today, too.

**Kids should be kids: Stop Internet companies from tracking and targeting them!**

It’s been 13 years since Congress passed an Internet privacy bill for kids, and the law hasn’t kept pace with technology. It’s virtually impossible nowadays for parents to protect their kids from unwanted online tracking and targeting – even if they’re looking over their shoulders.

The *Wall Street Journal* examined 50 popular kids’ websites two years ago, finding more than 4,000 hidden ‘cookies’ and tracking devices left behind. Some of these cookies are harmless. But data-collection companies also use these tools to follow kids online, creating profiles of their age, shopping habits, hobbies and general location. That data can be sold to advertisers and others, and parents can do little to stop it.

**But a bipartisan bill now in Congress would update the law to put control back in parents’ hands.** The bill would stop targeted Internet advertising to minors; prohibit the collection of personal and location information from children under 13 without parental consent; and increase protections for teens online.

**Add your voice today, and ask your members to support this bipartisan bill!**

Giving parents the tools to protect kids shouldn’t be a political issue, so urge your elected officials to get on board and support this bill. Please take action, then forward this to five of your friends and family so they can ask their members, too.

Sincerely,
.... How did we get here?

What technological innovations have brought us where we are today?
Integrated Circuits: Millions of logical gates

Cheaper fabrication, greater and greater complexity per inch
=> Miniaturization!!!!!
=> Everyone can afford!!
The Internet

- Invented in 1969 for military purposes, it took almost 20 years to get out of the lab.
- Communication by FTP (file transfer protocol).
- Ascii Terminal interface.
- E.g. 1983 War Games Film.
WWW + http: Early 90’s changed everything

- WWW: An INTERFACE!!
- All computers “speak” a common language: hyper-text transfer protocol. HTTP
- Content points to other content
  - (Google page rank, later)
  - UTF ensures content of pages in any language can be displayed
Kinds of questions

- Name some new technologies that make it easy to violate someone’s privacy
- Name some applications discussed in class that make it easy to violate someone’s privacy
- What do TIA and Google and Facebook have in common?
Contrast Two Videos: Surreptitious, Not

- **Star Wars Kid**
  - A/K/A Ghyslain Raza
  - Just messing around in drama studio at school
  - Other kids found and uploaded
  - [http://www.youtube.com/watch?v=HPPj6vilBmU](http://www.youtube.com/watch?v=HPPj6vilBmU)

- **Numa Numa Guy**
  - A/K/A Gary Brolsma
  - [http://www.youtube.com/watch?v=W9m9UFhEARg&feature=fvwrel](http://www.youtube.com/watch?v=W9m9UFhEARg&feature=fvwrel)
Posting Audio/Video Online: Good or Evil?

Alexandra Wallace original. 2.52 minutes
WikiLeaks – Changing democracy?

- **WikiLeaks Documentary.**
- 55 minutes long.
- First five minutes, plus from time 30 min – 35 minutes in class.
- Watch whole thing for homework!
Kinds of questions

- What do these examples show?
- Whose privacy was violated?
Processing ...

- Processing is a language for programming graphical and image-based computations
  - More fun than programming an operating system
  - Easier to do because we “see” what’s happening
  - Immediate feedback => bottom up programming style
Coding Is ALL Detail

- Notice everything!

- Two Functions, One Common Form:

```java
void <name> () {
}  \textit{all symbols + placement, matter}
```

- Every statement ends with a semicolon (;)

- The software colors text it understands – helpful

- Some functions include stuff inside parentheses; these are called \textit{arguments}

- If a function has arguments, each position has a specific meaning: `size(<width>, <height>);`

- `stroke(<red value>, <green value>, <blue value>);`

- If your cursor is by a closing parenthesis or brace, the matching parenthesis or brace is highlighted

- Keywords are highlighted in blue

- Processing is case sensitive; notice!
Week 3: More Processing, Bits and Bytes. Blinky, Logic Gates, Digital Representations, Huffman Coding
MP Neuron for XOR?
(EITHER X OR Y BUT NOT BOTH TRUE OR BOTH FALSE)
(NOT P) OR (NOT Q) vs. NOT (P AND Q)

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<th>P</th>
<th>Q</th>
<th>NOT P</th>
<th>NOT Q</th>
<th>P AND Q</th>
<th>NOT (P AND Q)</th>
<th>(NOT P) OR (NOT Q)</th>
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- NOT (P \land Q) = NOT P \lor NOT Q
- This is DeMorgan’s Law of Boolean Algebra
Logic to Gates and Back again

Draw the logic diagrams for the following logical statements.
(Note: You do not need to include the switches shown in the logic diagram above. You may represent your inputs with simple lines as shown in lecture.)

(a) NOT (P OR Q)

(b) (A OR B) AND (NOT C)

2.2

Create a truth table and write the logical statement for the following logic diagram. Consider the inputs A and B to have truth values like that of the switch in the picture; each is either on (true or 1) or off (false or 0).
## Binary combinations, True/False possibilities

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</tr>
<tr>
<td>00</td>
<td>100</td>
<td>0111</td>
</tr>
<tr>
<td>01</td>
<td>101</td>
<td>?011</td>
</tr>
<tr>
<td>10</td>
<td>110</td>
<td>?100</td>
</tr>
<tr>
<td>11</td>
<td>111</td>
<td>?110</td>
</tr>
</tbody>
</table>

*Note: '?' denotes a variable bit value.*
With 8 places how many different letters?
Coding can be used to do Compression

- **What is CODING?**
  - The conversion of one representation into another

- **What is COMPRESSION?**
  - Change the representation (digitization) in order to **reduce** size of data (number of bits needed to represent data)

- **Benefits**
  - **Reduce storage** needed
    - Consider growth of digitized data.
  - **Reduce** transmission cost / **latency** / bandwidth
  - When you have a 56K dialup modem, every savings in BITS counts, **SPEED**
    - Also consider telephone lines, texting
What makes it possible to do Compression?

- IN OTHER WORDS: When is Coding USEFUL?
- When there is **Redundancy**
  - Recognize repeating patterns
  - Exploit using
    - Dictionary
    - Variable length encoding
- When **Human perception is less sensitive** to some information
  - Can discard less important data
Huffman Code Algorithm Overview

- Order the symbols with least frequent first (will explain)
- Build a tree piece by piece...
- Encoding
  - Calculate frequency of symbols in the message, language
  - **JUST COUNT AND DIVIDE BY TOTAL NUMBER OF SYMBOLS**
  - Create binary tree representing “best” encoding
  - Use binary tree to encode compressed file
    - For each symbol, output path from root to leaf
    - Size of encoding = length of path
  - Save binary tree
Huffman Tree Construction 5

A: 3
H: 2

C: 5
E: 8

I: 7

1 0

1 1 0

111

110

10

00

01

E = 01
I = 00
C = 10
A = 111
H = 110
Huffman Coding

- How much wood could a woodchuck chuck?
- Peter Peter Pumpkin eater?
- How do these kinds of examples exploit the properties of Huffman coding?
Guest Lecture: Social media. Lifelogging. Digital Memory
Data types in Processing

- **Primitive data types**
  - `int`: numbers without a decimal point.
  - `boolean`: data type for the boolean values `true` or `false`.

- **Composite data types**
  - `color`: storing color values
  - Function `color(R, G, B);` creates a color that can be stored in variable of the `color` data type

```java
color colorBlinky = color(255, 0, 0);
```