Introduction

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CMPT 130, Slides #1
Introduction

- What *is* a computer, and Computing Science?
- What is software?
- What is a programming language?
Computers
And Computing Science
Characteristics of a Computer

- Computers come in many shapes and sizes
  - General Computers: laptops, PC, etc.
  - Special purpose: anti-lock brakes, toasters

- Characteristics of all computers...
  - Are very fast at.. (+, -, *, /)
  - Represent data..
  - Have large main memory to store and retrieve data
  - Accept input and produce output
  - Can be.. because programs stored in main memory (Von Neumann architecture)
How Smart Are Computers?

- Computers are very good at doing things that we find difficult to do quickly.
- But does that mean that computers are generally “smarter” than people?
Computers vs The Brain

- Alienware PC
  - Uses Intel Core i7
  - $\approx 175,000$ MIPS
- Lots of memory!
  - 8 to 64 GB of RAM
  - Thousands of GB of storage

- Human brain
  - Processing power estimated at 100 million MIPS
  - Memory estimated at 100,000 GB
What is Computer Science?

- It is the

  How could you describe this game board in words and numbers?

  How do you pick your next move?

  and
What is Computer Science?

- It is the study of algorithms and data structures including:
  - formal properties
  - hardware
  - programming languages
  - creating application
CS: How can you...

Support democracy and public health using only cell phones?

CMPT 276 students wrote Android survey creation/taking apps for VOTO Mobile in Africa
- Deliver surveys via text messages ("Do you have clean running water?")
- Deliver health advice to new mothers via text messages
CS: How can you...

Help local sports club members sign up online for weekly matches?

– CMPT 373 (Summer 2016) wrote it for Vancouver Rackets Club!
CS: How can you...

Support a human rights activist safely report atrocities from inside a brutal government?

Cryptography!

- Take a normal message and encrypt it so only one selected person can decode it.
CS: How can you...

Save lives from car accidents?
Car accidents kill ~1,250,000 people per year.

Autonomous vehicles & AI (Artificial Intelligence)?
– Can a computer be programmed to drive better than a human?
– Can its unwavering attention, fast processing, and sensors be safer?
– Can software defects kill people? (YES! Tesla)
CS: How can you...

Better diagnose and treat cancer?

Medical Imaging / Medical Devices

– Show 3D scan data to radiologist on 2D screen.
– Accurately control MRI machine to target just the one tiny area.
– Use a cell phone to collect medical data and transmit it to the hospital.
  (Cheap blood test in the middle of nowhere)
Software
Where Can We Find Computers?

- Telecommunications
- Medicine
- Information and Research
- Entertainment
- Finance
- Transportation
- ...

“I think there is a world market for maybe five computers”
Famous (mis)quote from IBM chairman, 1943
Hardware and Software

- Hardware refers to computer equipment
  - Central Processing Unit (CPU)
  - Hard disk
  - Input devices (mouse, keyboard)
  - Output devices (printer, monitor)
- Software refers to the programs that..
Software

- What is software?
  - A set of instructions for a computer.
  - Programming:...

- Why is programming (considered) hard?
  - Because we want to solve hard problems
    - Usually things we can’t easily do by hand
  - And because computers are fundamentally stupid
Writing Software

- Software tells a computer how to solve a problem
  - Human Example: Giving friend directions on how to find you in a movie theatre?
    - What does computer need?
- But, remember, computers are *stupid*
  - They can’t deal with ambiguity
  - Instructions must be precisely defined in perfect grammar
    - Bad: “Put yer hand up if ya want an A”
Algorithms and Programs

- **Algorithm**:...
  - May be in English: What is 5 plus 10?
  - May be in Pseudocode: print 5+10
  - May be in C++: cout <= 5 + 10;

- **Program**: An implementation of.. for the computer to execute.

- **C++ programs are very formal**
  - They must be written using..
  - They must be..
Euclid’s Algorithm

Input
positive integers $a$ and $b$

Output
the greatest common divisor (GCD) of $a$ and $b$

Algorithm
Repeat until $a$ and $b$ are the same value:
  if $a$ is greater than $b$:
    set $a$ to $a - b$
  else:
    set $b$ to $b - a$

Return $a$ as the answer

Try it when $a = 91$ and $b = 65$
Euclid Example

Repeat until $a$ and $b$ are the same value:
  if $a$ is greater than $b$:
    set $a$ to $a - b$
  else:
    set $b$ to $b - a$

Return $a$ as the answer

\[
\begin{array}{cc}
  a & b \\
  91 & 65 \\
  26 & 39 \\
  13 & 13 \\
\end{array}
\]
# Euclid’s Algorithm in C++

```cpp
int main()
{
    cout << "Calculates the GCD of two integers\n";
    cout << "Enter the first integer: ";
    int a = 0;
    cin >> a;

    cout << "Enter the second integer: ";
    int b = 0;
    cin >> b;

    while (a != b) {
        if (a > b) {
            a = a - b;
        } else {
            b = b - a;
        }
    }

    cout << "GCD = " << a << "\n";
}
```
Properties of an Algorithm

- Every step is unambiguous
  - You must specify exactly what to do.
- Input and output are clearly defined
  - Bad: “Add up some values”
    - What type of values? How many?
    - What to do with the answer?
- Must be executable in finite amount of time
  - Must finish before the end of time.
Developing Programs

- Analysis
  - What is the problem?
- Design
  - What is the solution?
- Programming
  - Write the program
- Testing
  - Make sure the program works
Programming Goals

- Correct
- Reliable
- Well designed
- Affordable
- Maintainable
Discussion in Groups of 3-4

- Exchange names & email addresses

- Answer the following:
  - For a computer to be “smarter” than a human, will it require? Hardware? Software?
  - What problems can you think of that are “hard” to compute? (Hard = take long time to solve)
  - For an 100% computer controlled car, what are some tasks that would be hard to program but are easy for humans to complete?
Programming Languages
Types of Languages

- A program is written using a...

- There are different kinds of these:
  - Machine language
  - Assembly language
  - High level languages
    - C, C++, Lisp, Python, Java, Fortran, Perl, ...
Machine Language

- Machine language can be processed directly by a computer.
- A program is a sequence of instructions.
  - Each instruction code is...
  - Each number represented in binary.
- Machine languages are very hard for humans to..

Part of iTunes --> (Trust me)
Assembly Language

- Assembly languages are..
- Assembly language directly translates to machine code
- Commands are at a..
- Finding a '1' in some data can take many lines.
  (see example on right)

```
.data
arr: .word 2, 2, 3, 4, 5, 6, 7, 8, 1, 5, 8

.text
main:
  la $s5, arr
  addi $s1, $zero, 1
  add $s3, $zero, $zero

loopstart:
  sll $t0, $s3, 2
  add $t0, $t0, $s5
  lw $t1, 0($t0)
  beq $t1, $s1, loopend
  addi $s3, $s3, 1
  j loopstart

loopend:
  addi $t2, $s3, 0
```
High Level Languages

- High level languages are much easier to..

- C++ is a high level programming language
  - Compiles into machine code before executed

- Programming languages are formal and lack the richness of human languages
  - If a program is *nearly*, but not quite syntactically correct then it will..
  - The compiler will *not* “figure it out”
Brief History of C++

- C created in 1972 by Dennis Ritchie of Bell Labs
  - Use for writing and maintaining Unix (the OS).
  - Popular for low level system programs.
- C++ created in 1980's by Bjarne Stroustrup at AT&T.
  - Includes most of C as a subset of the language.
  - C++ is often “cleaner” than C (less error prone).
  - C++ supports Object Oriented Programming (CMPT 135).
- (There is no C+ language!)
Why C++?

- Generates efficient programs
  - Compact and run quickly (popular for games/OS/etc)
- Portable
  - Programs from one system can be run with little modifications on other systems (often...)
  - Useful for embedded systems
- Flexible
  - Allows programmers a lot of control
- We'll focus on the C-ish subset of C++, so working in straight C will not be very different from the work you do in this course.
Summary

- Computers are very fast, but not intelligent.
- Algorithm: a set of instructions for solving a problem.
- Software: a set of instructions for a computer.
- Programming Languages:
  - Higher level languages easier to read and write.