Introduction

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CMPT 130, Slides #1

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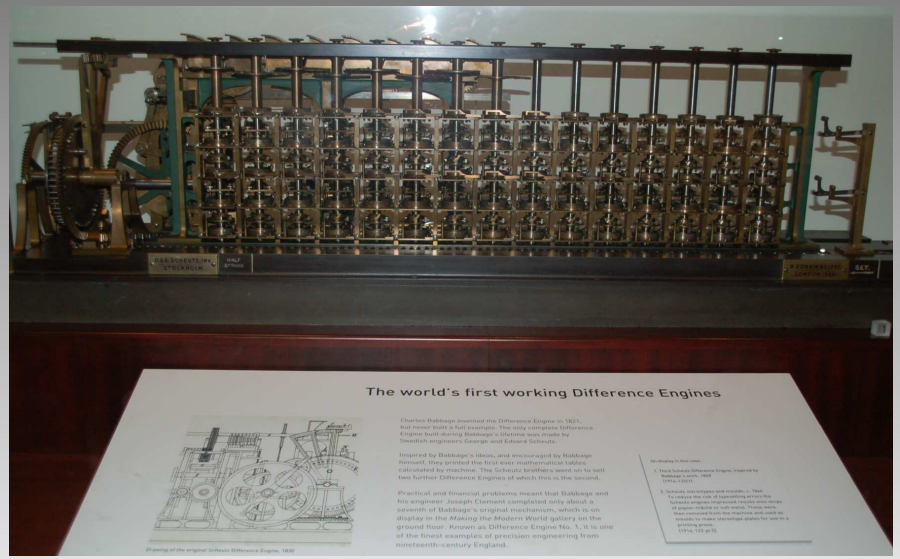
Introduction

- What is a computer, and Computer 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 are 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 i9
  - ≈ 500,000 MIPS¨
- Lots of memory!
  - 64 GB of RAM
  - 4 TBs of storage

- Human brain
  - Processing power estimated at 100,000,000 MIPS
  - Memory estimated at 100 TB

What is Computer Science?

- It is the *and*

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

How do you pick your next move?

What is Computer Science?

- It is the study of algorithms and data structures including:
  - formal properties
  - hardware
  - programming languages
  - creating application

Software

Image by Pixabay on Pexels

Where Can We Find Computers?

- Computer Systems are ubiquitous
  - Telecommunications
  - Medicine
  - Information and Research
  - Entertainment
  - Finance
  - Transportation
  - …
- Many such systems are critical

"I think there is a world market for maybe five computers"
IBM chairman, 1943

Hardware and Software

- Hardware refers to computer equipment
  - Central Processing Unit (CPU)
  - Secondary memory
  - Input devices
  - Output devices

- 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

Devising a Process

Image by Ahmed akacha on Pexels

Reunite Families

- Imagine you are an **aid worker** in a small city during a earthquake.
  - Most of the town is destroyed, but the **open-air stadium** is still standing.
  - Survivors are being directed to the stadium which is big enough to hold all the survivors.
- In a group of 3-4, you must **devise a protocol by which survivors may be reunited with their nuclear family** before they are able to move to some red-cross tents.
  - Aid workers have a bull-horn to talk to many people at once.
  - Also have pen/paper, and other resources. No cell phones.
  - Think about handling many people efficiently.

Algorithms and Programs

- Algorithm:..
  - May be in English: Write the sum of 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

a	b
~~91~~	~~65~~
~~26~~	~~39~~
13	13

Result

Euclid's Algorithm in C++

```
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

Programming Languages

Image by Anna Shvets on Pexels

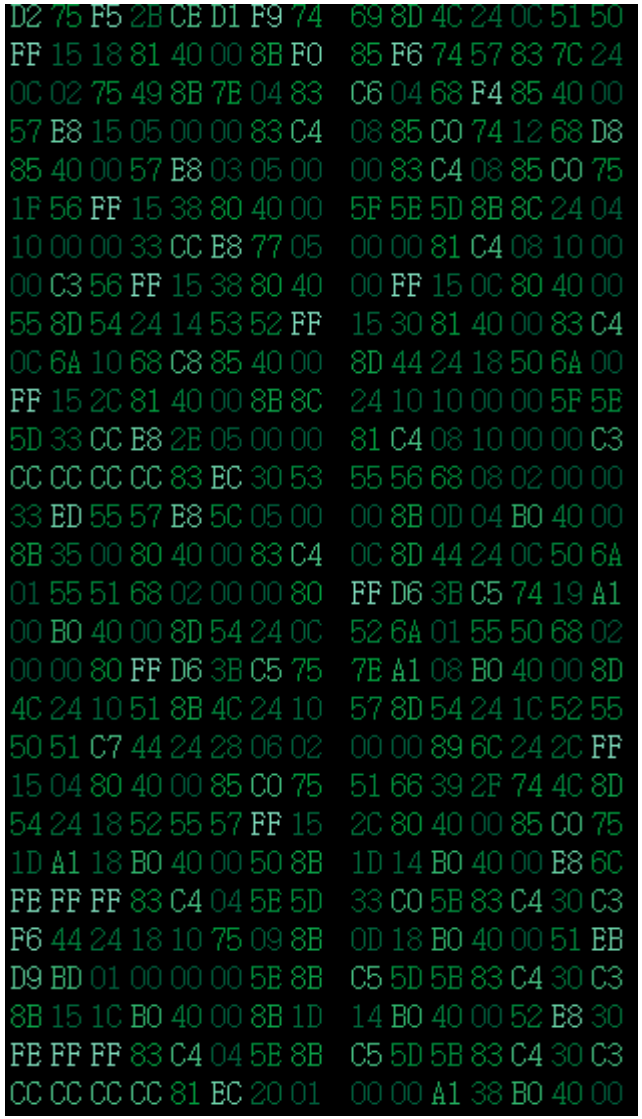
Types of Languages

- A program is written using a..
- There are different kinds of these:
  - Machine language
  - Assembly language
  - High level languages
    - C, C++, JavaScript, Python, Java, Fortran, Rust, …

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 create 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).
  - Updated often: …C++03, C++11, C++14, C++17, C++20…
- (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
- What we'll cover has some similarity to parts of C, so if you need to work in plain C it should be familiar

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.