

Introduction



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Modified by Brian Fraser
CMPT 130, Slides #1

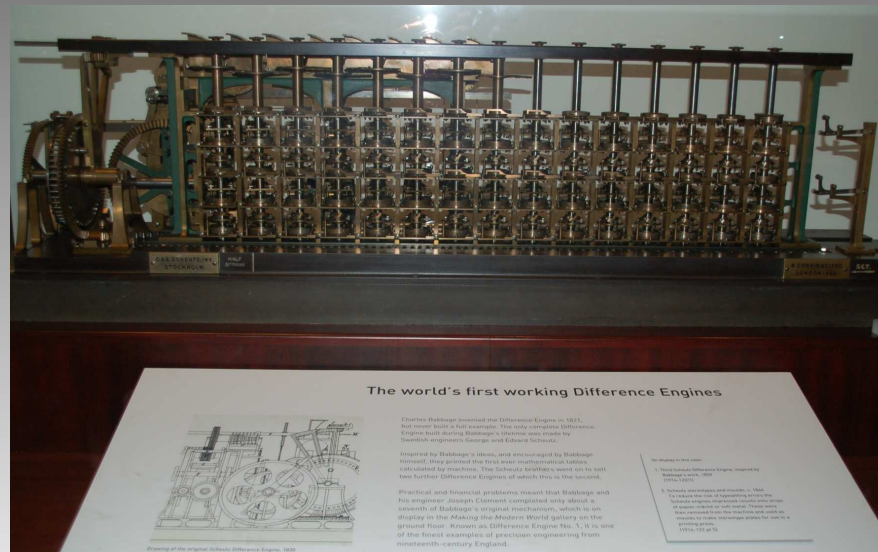
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Introduction

- 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
- $\approx 500,000$ 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

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



and

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



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Where Can We Find Computers?

- Computer Systems are ubiquitous

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

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

- Many such systems are critical



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 alacha 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 $a - b$

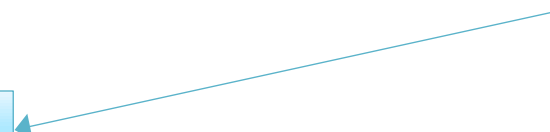
else:

set b to $b - a$

Return a as the answer

a	b
91	65
26	39
13	13

Result



Euclid's Algorithm in C++

// Sample program to find the greatest-common-denominator (GCD) of two integers.

```
#include <iostream>
#include <print>
using namespace std;

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

    println("Enter the second integer: ");
    int b = 0;
    cin >> b;

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

    println("GCD = {}", a);
    return 0;
}
```

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 Shvers 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)

```
D2 75 F5 2B CE D1 F9 74 69 8D 4C 24 0C 51 50
FF 15 18 81 40 00 8B F0 85 F6 74 57 83 7C 24
0C 02 75 49 8B 7E 04 83 C6 04 68 F4 85 40 00
57 E8 15 05 00 00 83 C4 08 85 C0 74 12 68 D8
85 40 00 57 E8 03 05 00 00 83 C4 08 85 C0 75
1F 56 FF 15 38 80 40 00 5F 5E 5D 8B 8C 24 04
10 00 00 33 CC E8 77 05 00 00 81 C4 08 10 00
00 C3 56 FF 15 38 80 40 00 FF 15 0C 80 40 00
55 8D 54 24 14 53 52 FF 15 30 81 40 00 83 C4
0C 6A 10 68 C8 85 40 00 8D 44 24 18 50 6A 00
FF 15 2C 81 40 00 8B 8C 24 10 10 00 00 5F 5E
5D 33 CC E8 2E 05 00 00 81 C4 08 10 00 00 C3
CC CC CC CC 83 EC 30 53 55 56 68 08 02 00 00
33 ED 55 57 E8 5C 05 00 00 8B 0D 04 B0 40 00
8B 35 00 80 40 00 83 C4 0C 8D 44 24 0C 50 6A
01 55 51 68 02 00 00 80 FF D6 3B C5 74 19 A1
00 B0 40 00 8D 54 24 0C 52 6A 01 55 50 68 02
00 00 80 FF D6 3B C5 75 7E A1 08 B0 40 00 8D
4C 24 10 51 8B 4C 24 10 57 8D 54 24 1C 52 55
50 51 C7 44 24 28 06 02 00 00 89 6C 24 2C FF
15 04 80 40 00 85 C0 75 51 66 39 2F 74 4C 8D
54 24 18 52 55 57 FF 15 2C 80 40 00 85 C0 75
1D A1 18 B0 40 00 50 8B 1D 14 B0 40 00 E8 6C
FE FF FF 83 C4 04 5E 5D 33 C0 5B 83 C4 30 C3
F6 44 24 18 10 75 09 8B 0D 18 B0 40 00 51 EB
D9 BD 01 00 00 00 5E 8B C5 5D 5B 83 C4 30 C3
8B 15 1C B0 40 00 8B 1D 14 B0 40 00 52 E8 30
FE FF FF 83 C4 04 5E 8B C5 5D 5B 83 C4 30 C3
CC CC CC CC 81 EC 20 01 00 00 A1 38 B0 40 00
```

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.