COMP110: Principles of Computing

1: Computing Foundations

Learning outcomes

By the end of today's session, you will be able to:

- **Recall** the historical context of computing and gaming technology
- **Explain** the basic architecture of a computer
- **Distinguish** the most common programming languages and paradigms in use today

Today's agenda

- COMP110 course outline
- History of computing
- Computer architecture
- Programming languages and paradigms

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Course introduction

From the module guide

This module is designed to introduce you to the basic principles of computing and programming in the context of digital games. It is designed to complement the other modules through providing a broad foundation on the different methods and techniques which will help you to be able to construct computer programs and able to use relevant scholarly sources. You will gain an understanding of software development and the various roles, pipelines, and terminology used within game development.

Topic schedule

On LearningSpace...

Timetable

http://mytimetable.falmouth.ac.uk

Assignments

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- Assignment 1: worksheet tasks

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  - **Five** worksheets throughout the study block

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- See LearningSpace for assignment briefs, worksheets, quizzes

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- See MyFalmouth for deadlines

Worksheet A

- SpaceChem
- Quiz: Pythagoras' Theorem
- Due in class on **Friday 6th October** (next week)

Personal tutor meetings

`http://learningspace.falmouth.ac.uk`

- You **must** meet your personal tutor at least **twice** per study block
- If you haven't booked a meeting yet, do it **now**!

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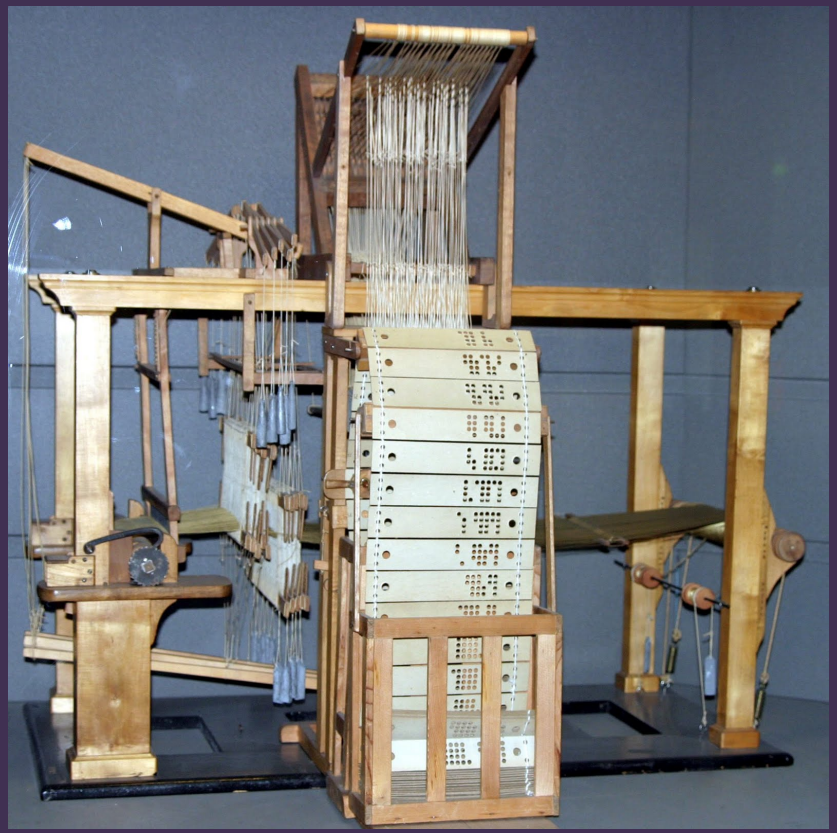
What was the first computer?

Antikythera Mechanism ($\sim$150 BC)

First mechanical computer?

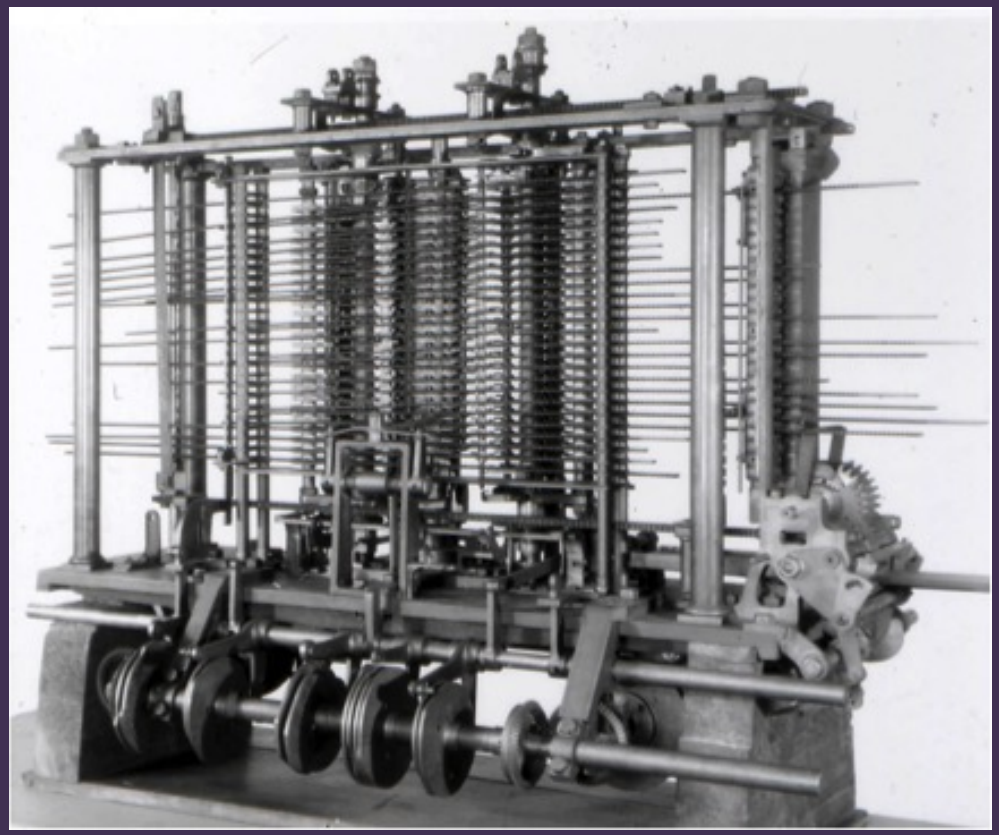
Jacquard Loom (1804)

First programmable machine in modern age



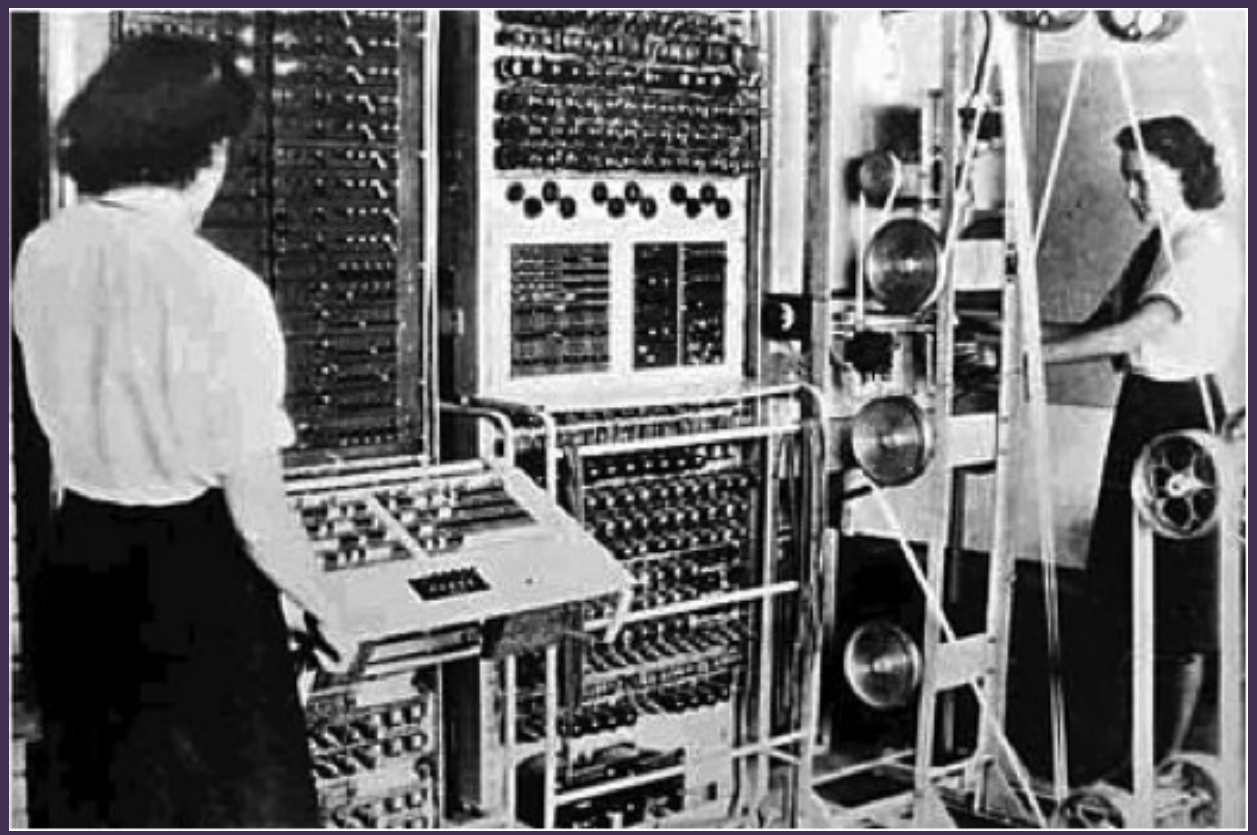
Babbage's Difference and Analytical Engines (1837)

First mechanical computer in modern age



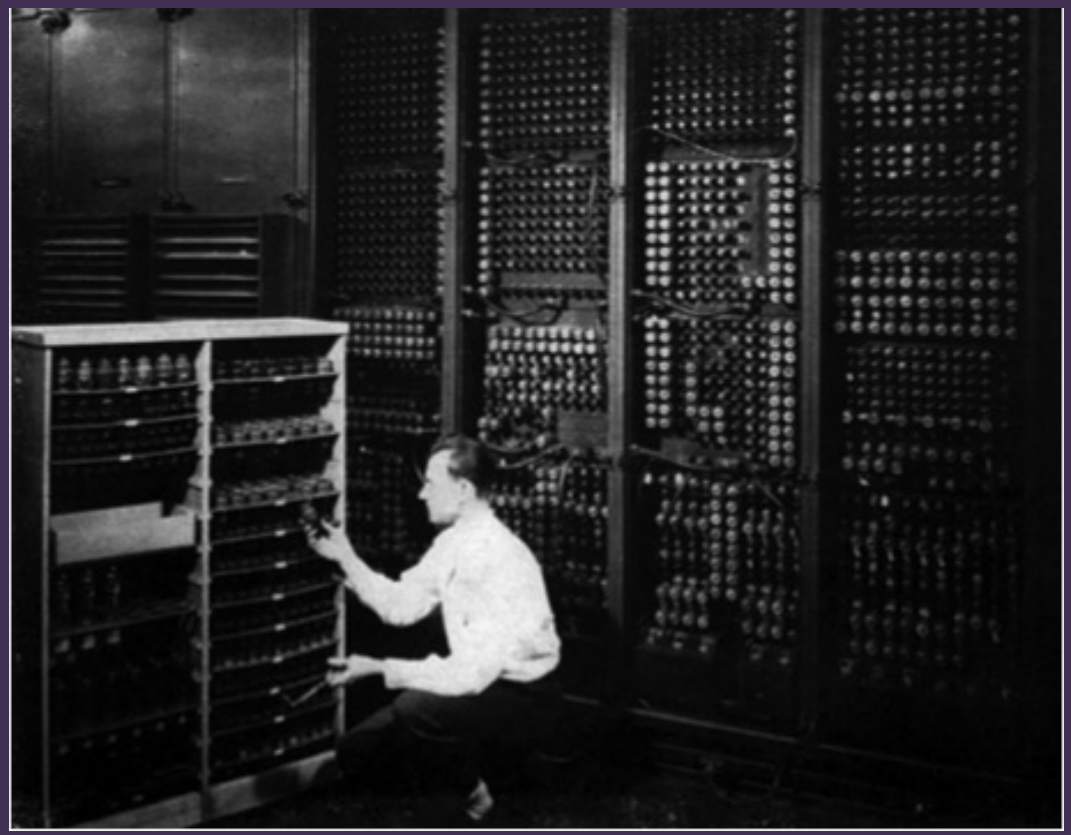
Colossus (1943)

First programmable electronic computer



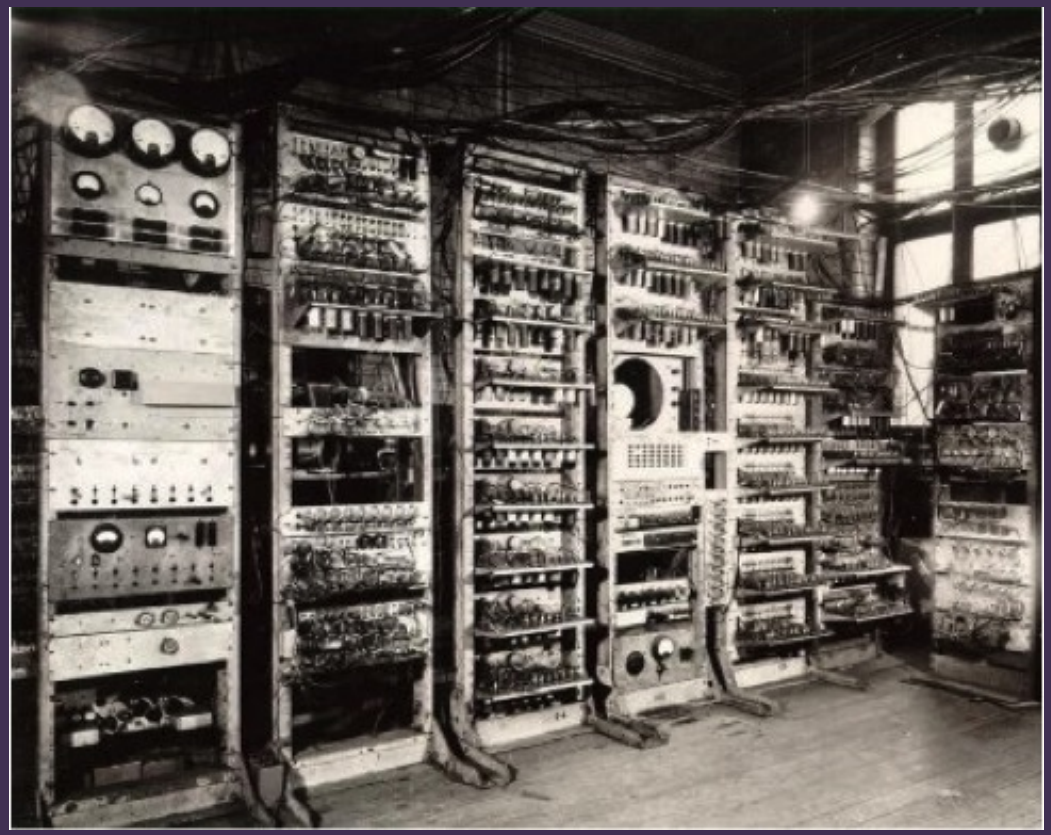
ENIAC (1946)

First general-purpose computer



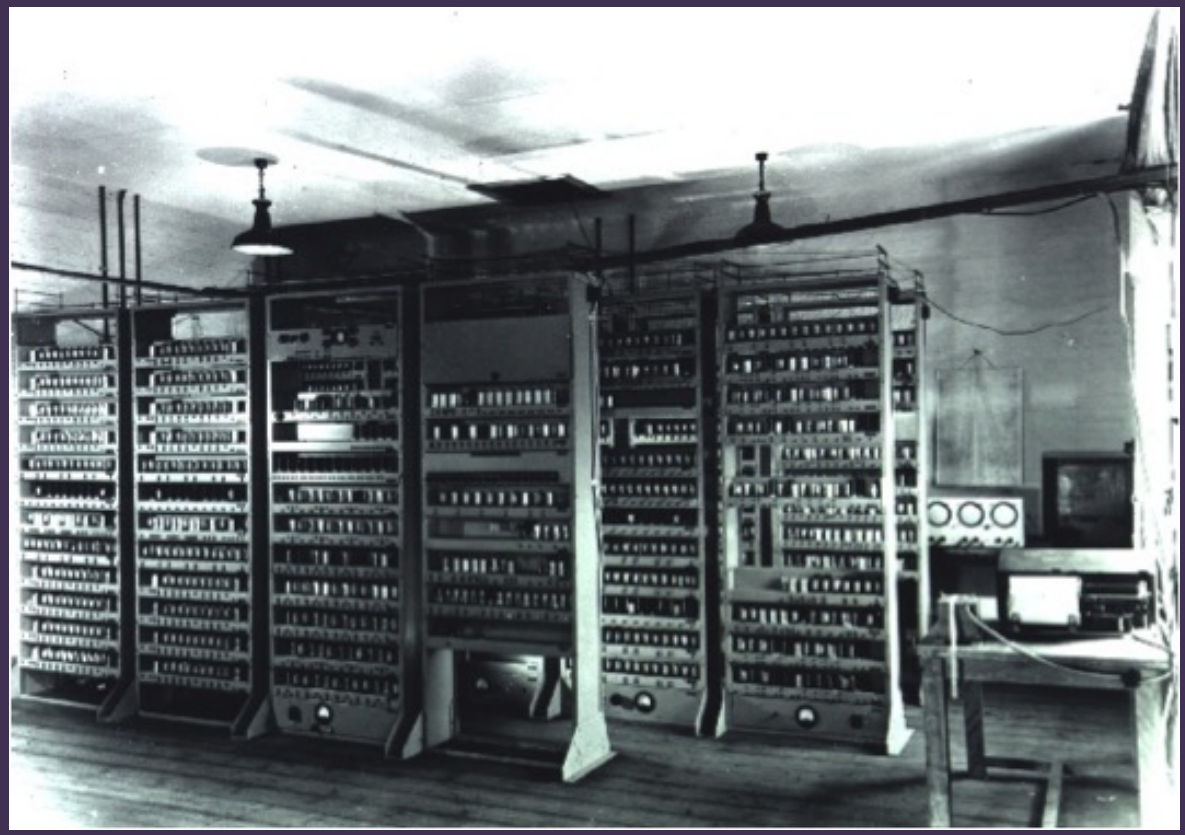
Manchester Small-Scale Experimental Machine (1948)

First stored program computer



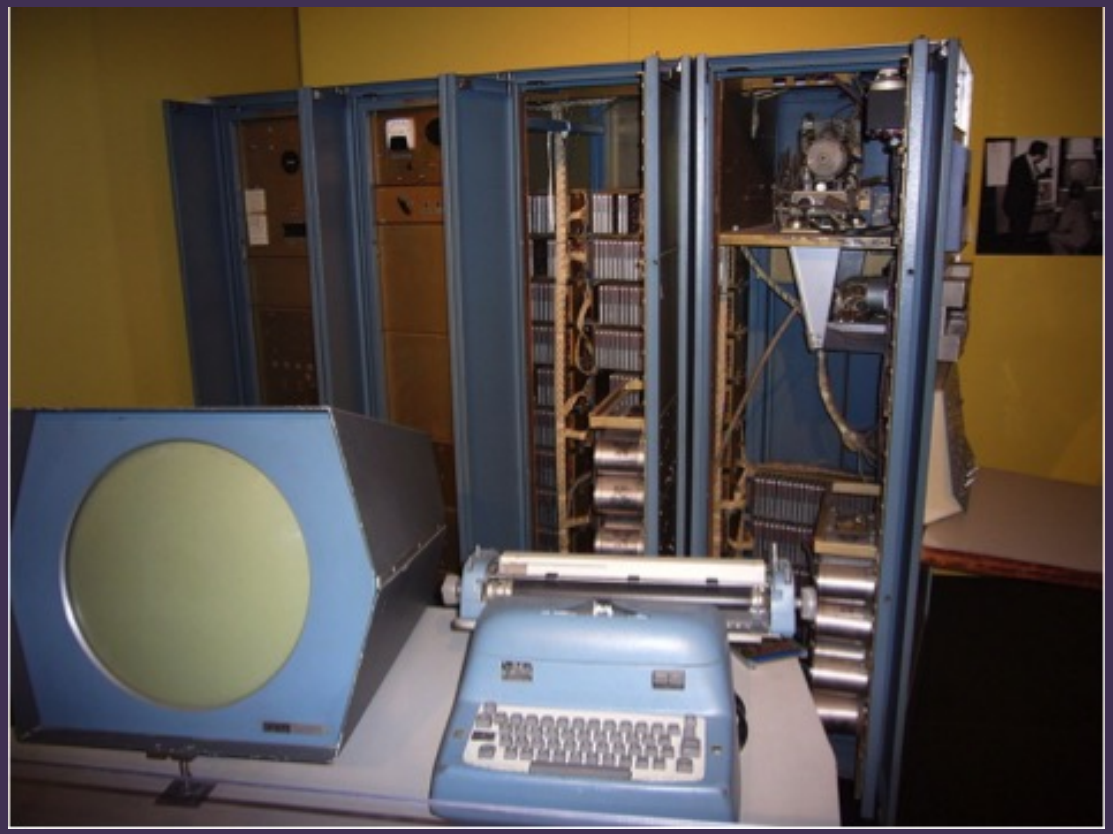
EDSAC (1949)

Many firsts in mathematics and science



PDP-1 (1959)

Influenced “hacker culture”



Datapoint 2200 (1970)

First microcomputer

Commodore VIC 20 (1980)

First computer to sell 1 million units

IBM Personal Computer Model 5150 (1981)

Precursor to the modern PC

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What was the first computer game?

Cathode Ray Tube Amusement Device (1948)

First interactive electronic game

Chess AI on the Ferranti Mark I (1951)

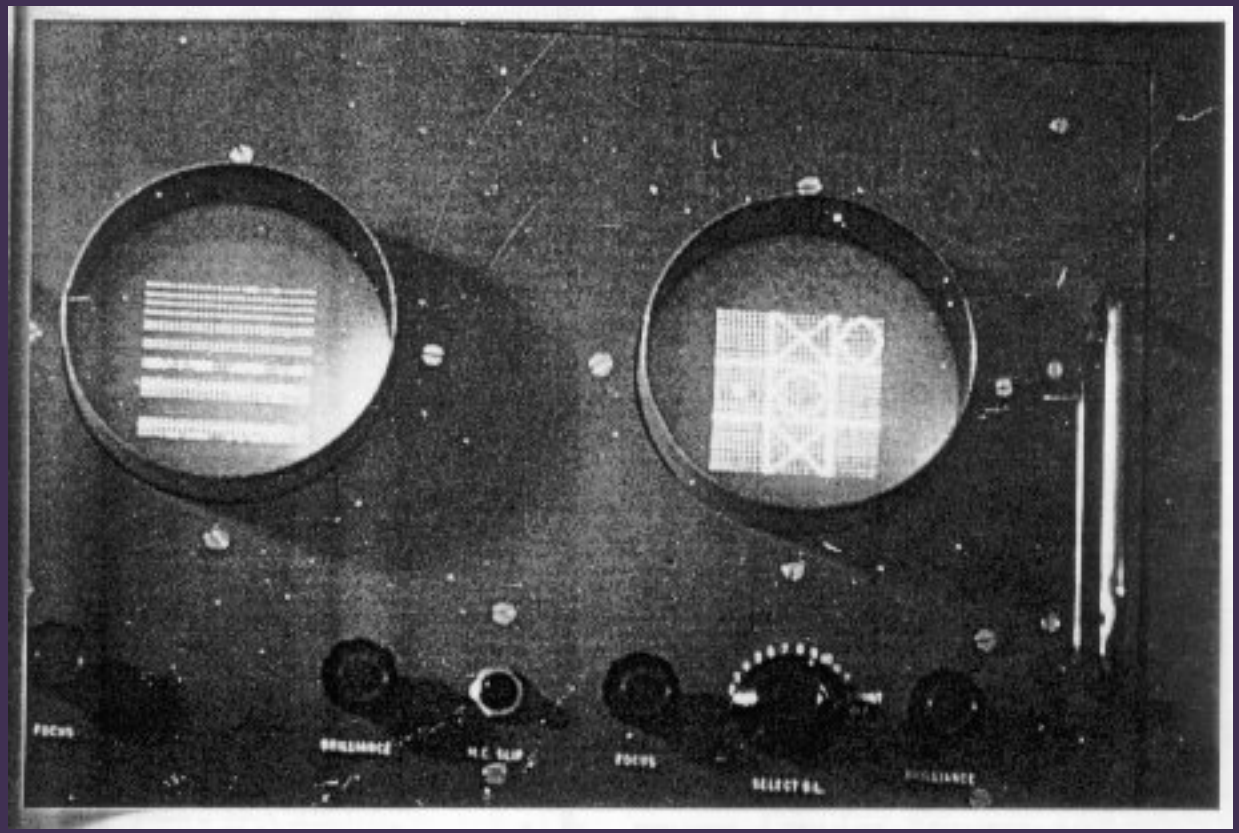
First chess program

Bertie the Brain (1950)

First computer game with a visual display

OXO (1951)

First game with visuals on a general-purpose computer



Tennis for Two (1959)

First to be created purely for entertainment

SpaceWar! (1962)

First widely available game, inspired first arcade games

Pong (1972)

First commercially successful game

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What was the first games console?

The Brown Box (1967)

First prototype console

Magnavox Odyssey (1972)

First commercial console

Game console timeline

http://www.onlineeducation.net/videogame_timeline/video-game-timeline.jpg

(A little out of date!)

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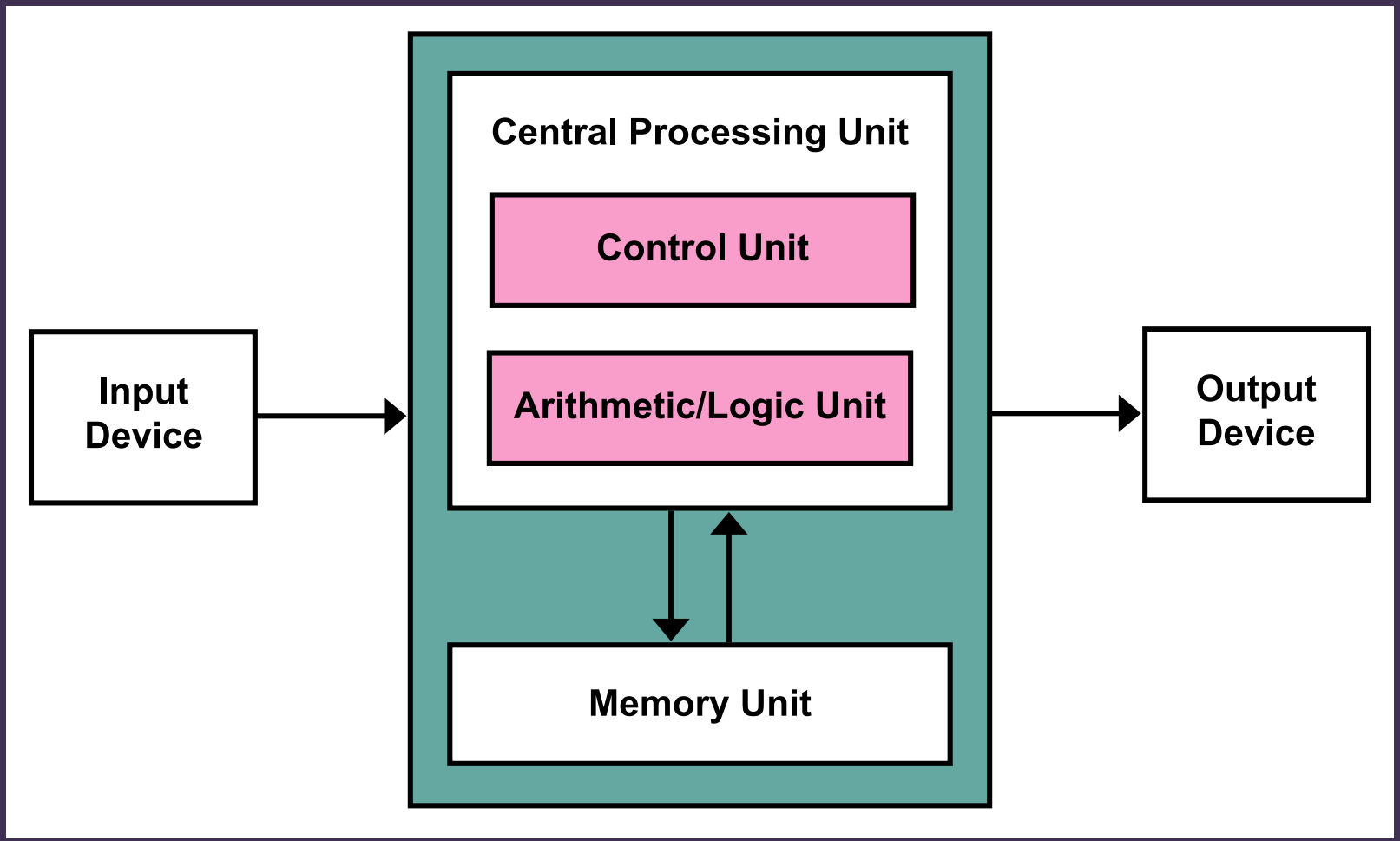
Basic computer architecture

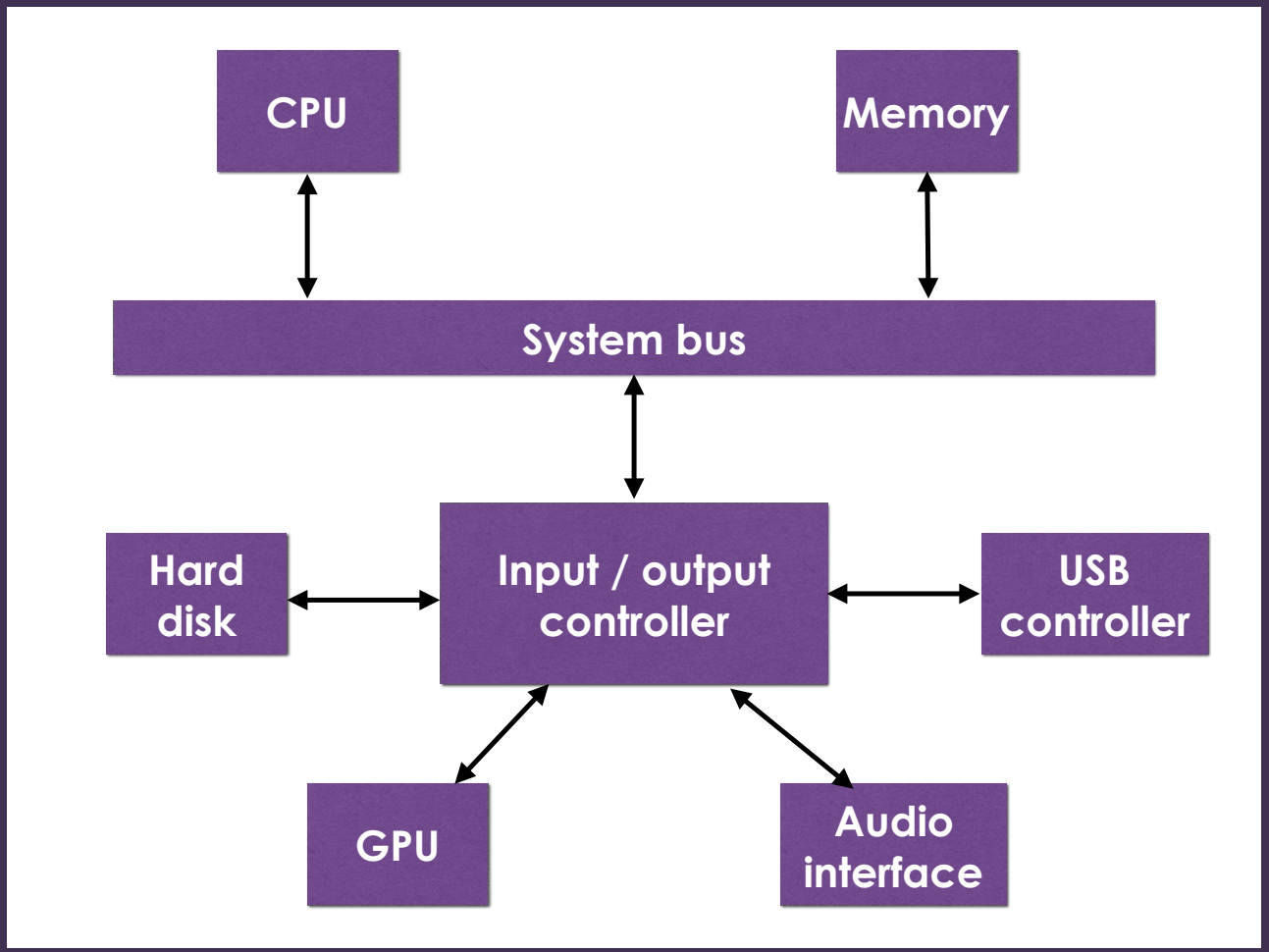
What is a computer?

- In **groups of 2-3**
- Discuss for **10 minutes**
- Go to `www.socrative.com` (or open the Socrative app) and enter room code `FALCOMPED`
- **Individually**, suggest a **one sentence** definition for a computer

The Von Neumann model



Modern PC architecture



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- Arithmetic operations

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- Logic operations

Central processing unit (CPU)

Carries out

- Arithmetic operations
- Logic operations
- Control operations

Storage

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- Primary storage

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  - Directly accessible by the CPU

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  - Random access memory (RAM)

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- Nowadays, essentially a highly specialised CPU with its own primary storage

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The stored program architecture

- A **computer program** is a sequence of instructions for the CPU
  - (Note: it's spelled "program", not "programme")
- The **programmable computer** — can carry out different tasks depending on what program it is given
- Most modern computers use the **same** memory to store the program and the data it uses

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Programming languages and paradigms

What is a programming language?

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- A **program** is a sequence of instructions for a computer to perform a specific task
- A **programming language** is a formal language for communicating these sequences of instructions

Which is the best programming language?

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- There is no "best" programming language
- There are hundreds of programming languages, each better suited to some tasks than others
- Sometimes your choice is dictated by your choice of platform, framework, game engine etc.
- To become a better programmer (and maximise your employability) you should learn several languages (but one at a time!)

Low vs high level

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Low vs high level

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- **High level languages** give the programmer **abstraction**, hiding the details of the hardware
- High level languages trade efficiency for ease of programming
- Lower level languages were once the choice of game programmers, but advances in hardware mean that higher level languages are often a better choice

Programming paradigms

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- **Functional**: procedures are treated as mathematical objects that can be passed around and manipulated
- **Declarative**: does not define the control flow of a program, but rather defines logical relations

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Which paradigm?

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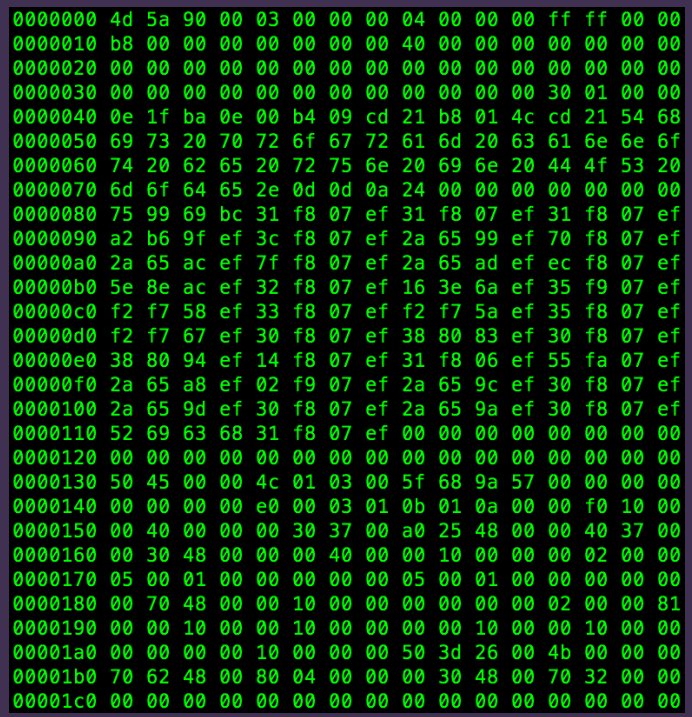
- Most commonly used languages today are a mixture of **procedural** and **object-oriented** paradigms, with many also incorporating ideas from **functional** programming
- Purely **functional** languages are mainly used in academia, but favoured by some programmers
- Purely **declarative** languages have uses in academia and some special-purpose languages

Machine code

```
0000000 4d 5a 90 00 03 00 00 00 04 00 00 00 ff ff 00 00
0000010 b8 00 00 00 00 00 00 00 40 00 00 00 00 00 00 00
0000020 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00
0000030 00 00 00 00 00 00 00 00 00 00 00 00 30 01 00 00
0000040 0e 1f ba 0e 00 b4 09 cd 21 b8 01 4c cd 21 54 68
0000050 69 73 20 70 72 6f 67 72 61 6d 20 63 61 6e 6e 6f
0000060 74 20 62 65 20 72 75 6e 20 69 6e 20 44 4f 53 20
0000070 6d 6f 64 65 2e 0d 0d 0a 24 00 00 00 00 00 00 00
0000080 75 99 69 bc 31 f8 07 ef 31 f8 07 ef 31 f8 07 ef
0000090 a2 b6 9f ef 3c f8 07 ef 2a 65 99 ef 70 f8 07 ef
00000a0 2a 65 ac ef 7f f8 07 ef 2a 65 ad ef ec f8 07 ef
00000b0 5e 8e ac ef 32 f8 07 ef 16 3e 6a ef 35 f9 07 ef
00000c0 f2 f7 58 ef 33 f8 07 ef f2 f7 5a ef 35 f8 07 ef
00000d0 f2 f7 67 ef 30 f8 07 ef 38 80 83 ef 30 f8 07 ef
00000e0 38 80 94 ef 14 f8 07 ef 31 f8 06 ef 55 fa 07 ef
00000f0 2a 65 a8 ef 02 f9 07 ef 2a 65 9c ef 30 f8 07 ef
0000100 2a 65 9d ef 30 f8 07 ef 2a 65 9a ef 30 f8 07 ef
0000110 52 69 63 68 31 f8 07 ef 00 00 00 00 00 00 00 00
0000120 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00
0000130 50 45 00 00 4c 01 03 00 5f 68 9a 57 00 00 00 00
0000140 00 00 00 00 e0 00 03 01 0b 01 0a 00 00 f0 10 00
0000150 00 40 00 00 00 30 37 00 a0 25 48 00 00 40 37 00
0000160 00 30 48 00 00 00 40 00 00 10 00 00 00 02 00 00
0000170 05 00 01 00 00 00 00 00 05 00 01 00 00 00 00 00
0000180 00 70 48 00 00 10 00 00 00 00 00 00 02 00 00 81
0000190 00 00 10 00 00 10 00 00 00 00 10 00 00 10 00 00
00001a0 00 00 00 00 00 10 00 00 00 50 3d 26 00 4b 00 00
00001b0 70 62 48 00 80 04 00 00 00 30 48 00 70 32 00 00
00001c0 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00
```

Machine code



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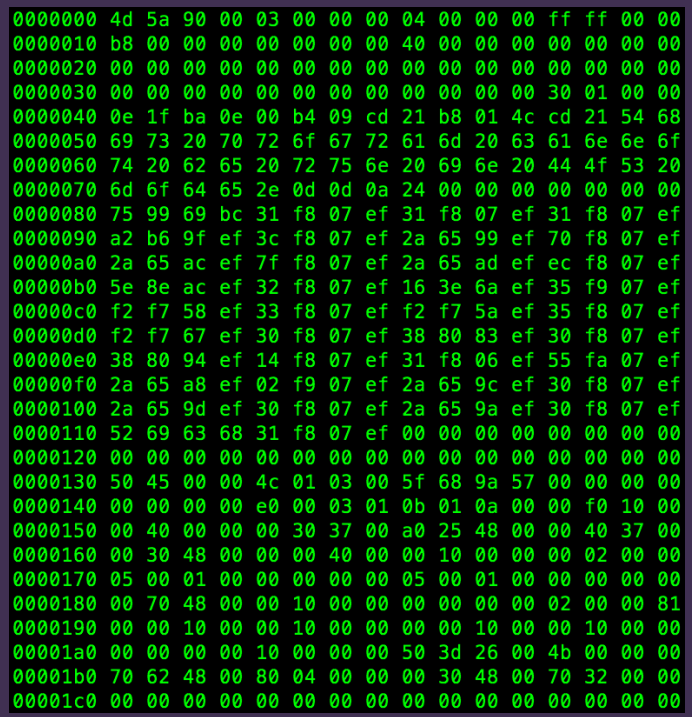

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- More on this later in the module

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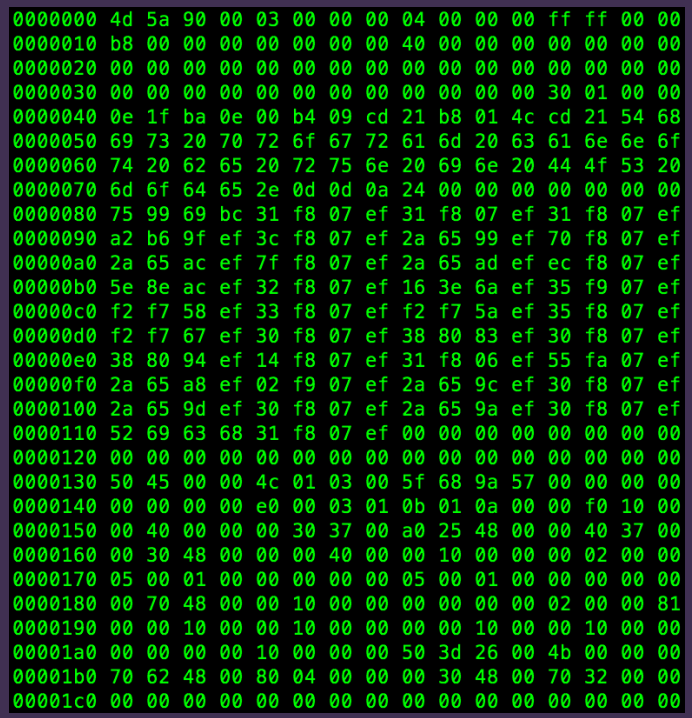

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- More on this later in the module
- Nobody has actually written programs in machine code since the 1960s...

Assembly language

```
section     .text
global      _start

_start:

    mov     edx,len
    mov     ecx,msg
    mov     ebx,1
    mov     eax,4
    int     0x80

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- Allows very fine control over the hardware...
- ... but difficult to use as there is no **abstraction**
- Also not portable between CPU architectures

C++

```
#include "stdafx.h"
#include "GameObject.h"
#include "CoinGame.h"

GameObject::GameObject(CoinGame* game, Texture* sprite)
	: game(game), sprite(sprite), isDead(false)
{
	x = rand() % CoinGame::WINDOW_WIDTH;
	y = rand() % CoinGame::WINDOW_HEIGHT;
}


GameObject::~GameObject()
{
}

void GameObject::render(SDL_Renderer* renderer)
{
	sprite->render(renderer, x, y, CoinGame::SPRITE_SIZE, CoinGame::SPRITE_SIZE);
}

bool GameObject::checkCollision(int otherX, int otherY)
{
	double distance = sqrt(pow(otherX - x, 2) + pow(otherY - y, 2));
	return (distance < CoinGame::SPRITE_SIZE / 2);
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- Low level (though higher level than assembly)
- Used by developers of game engines, and games using many popular “AAA” engines (Unreal, Source, CryEngine, ...)
- Also used by developers of operating systems and embedded systems, but falling out of favour with other software developers

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- JavaScript (HTML5 browser games)

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Often favoured by smaller indie teams for rapid development

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- Java (Minecraft, Android games)

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There are many others, but these are the most commonly used in game development

Scripting languages

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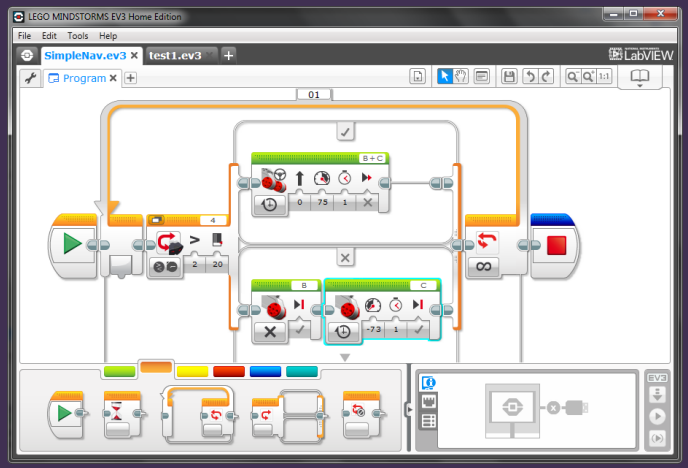
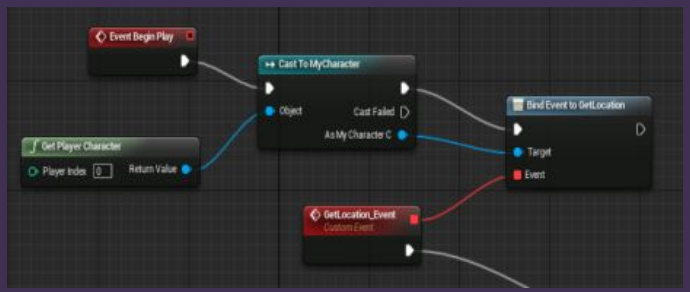
Some game engines have their own scripting language

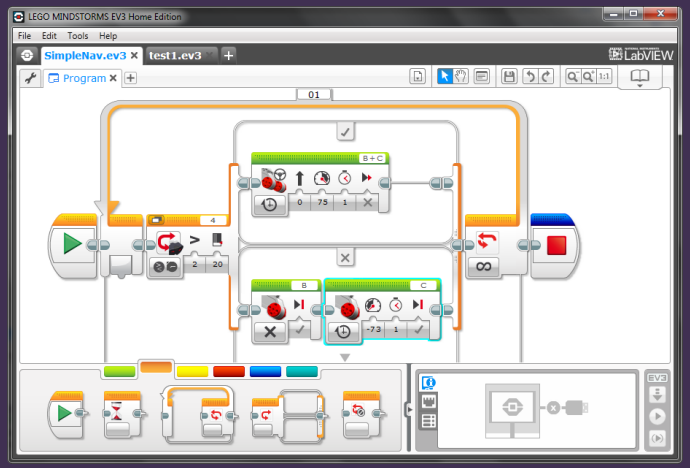
- UnrealScript, Blueprint (Unreal Engine)
- GML (GameMaker)

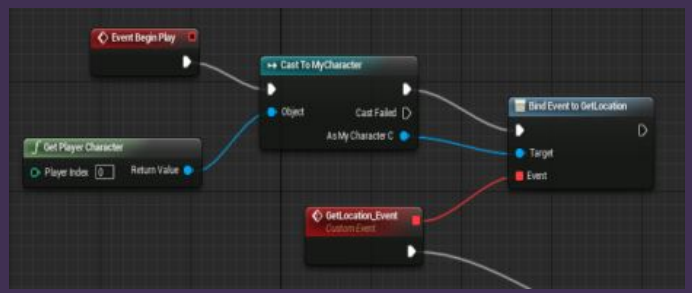
Visual programming languages





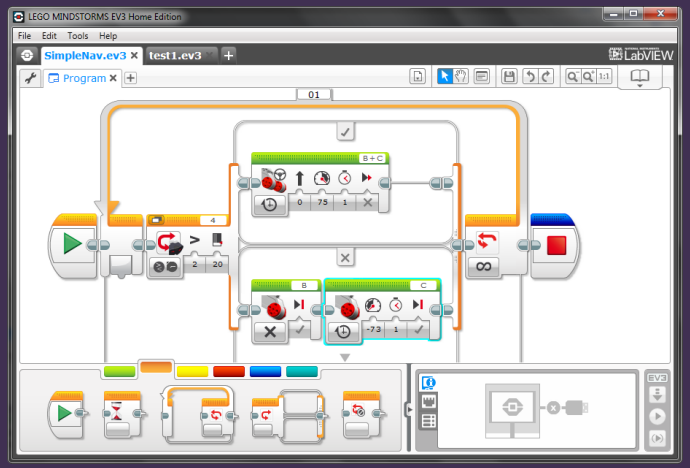
Visual programming languages

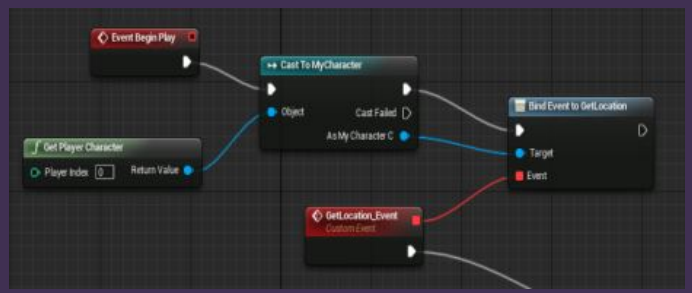




Based on connecting graphical blocks rather than writing code as text

Visual programming languages





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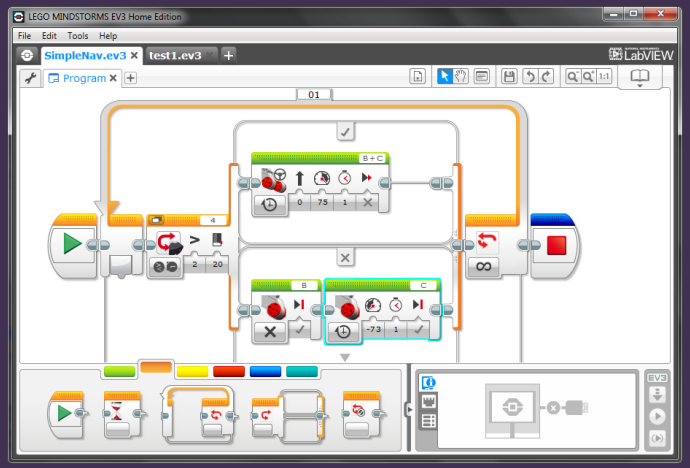

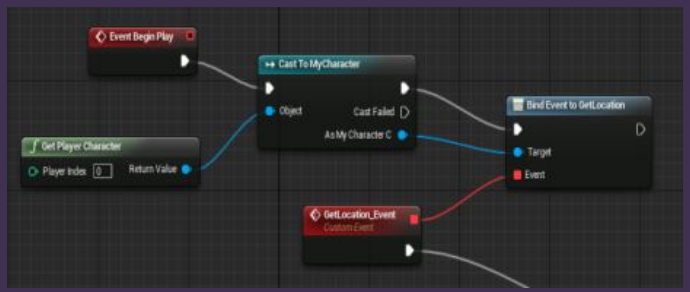

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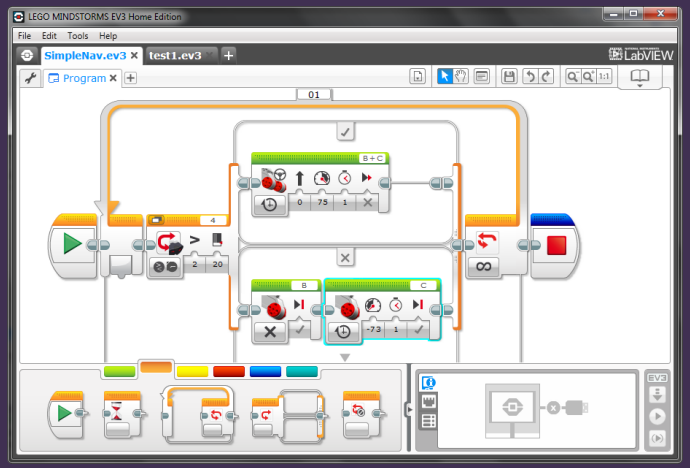
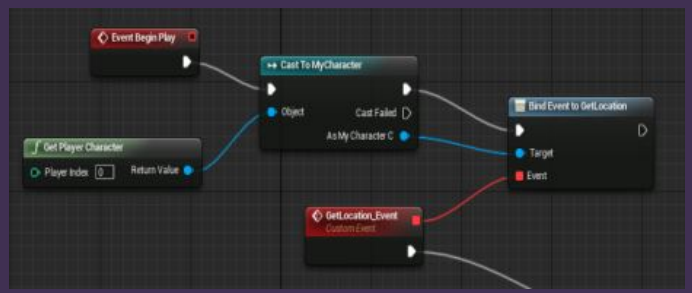
Visual programming languages





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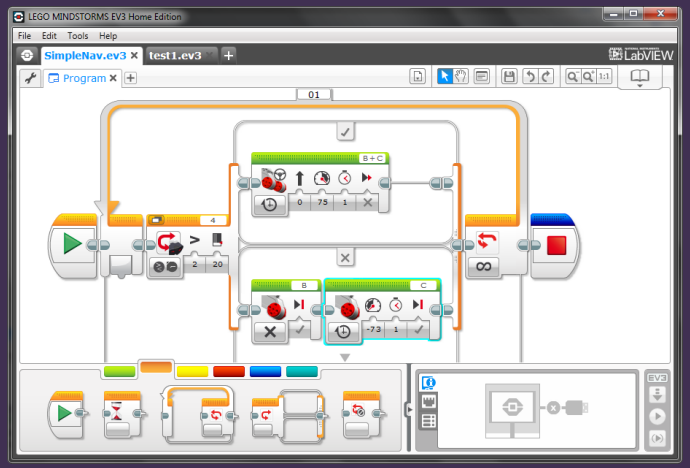

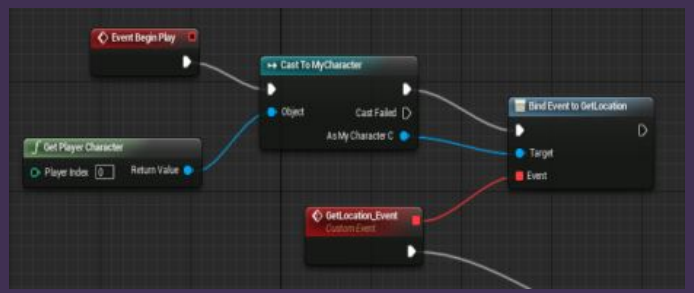

- Based on connecting graphical blocks rather than writing code as text
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Note: despite the name, Microsoft Visual Studio is **not** a visual programming environment!

Special purpose languages

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- SQL (database queries)

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- GLSL, HLSL (GPU shader programs)

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- SQL (database queries)
- GLSL, HLSL (GPU shader programs)
- LEX, YACC (script interpreters)

Markup languages

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- HTML, CSS (web pages)

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- HTML, CSS (web pages)
- LaTeX, Markdown (documentation)

Markup languages

Not to be confused with programming languages...

- HTML, CSS (web pages)
- LaTeX, Markdown (documentation)
- XML, JSON (data storage)

Which programming language is most popular?

http://githut.info

“Family tree” of programming languages

https://www.levenez.com/lang/lang.pdf

Debrief

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You should now be able to:

- **Recall** the historical context of computing and gaming technology
- **Explain** the basic architecture of a computer
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Remember: Worksheet A is due **this time next week**!