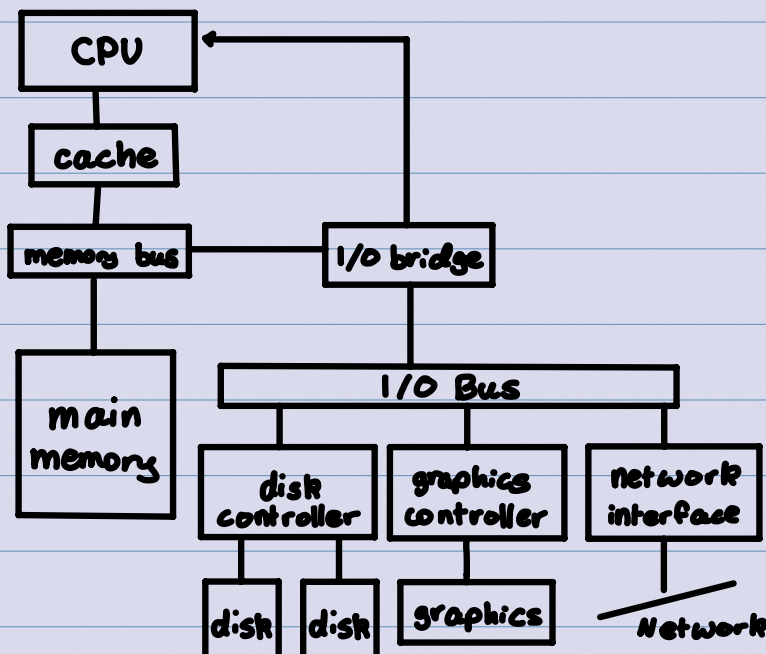# Lecture 1 - 4th Sept 2024

Instruction Set Architecture: how hardware executes software

- What is a computer?
  - └ just a machine that does whatever the software tells it to do.
  - └ computer > digital circuits > logic gates > transistors
  - └ Software is just a series of instructions.
  - └ The five classic components of a computer:
    - CPU: Central Arithmetic (ALU) and Central Control
    - Memory System
    - Input and Output

└ But, here's a more realistic view:

```
         ┌───────┐
         │  CPU  │◄──────────────┐
         └───┬───┘               │
         ┌───┴───┐               │
         │ cache │               │
         └───┬───┘               │
     ┌───────┴────┐      ┌────────────┐
     │ memory bus │──────│ I/O bridge │
     └───────┬────┘      └──────┬─────┘
             │                  │
        ┌────┴───┐   ┌──────────┴──────────────────┐
        │        │   │          I/O Bus            │
        │ main   │   └──┬────────────┬──────────┬──┘
        │ memory │   ┌──┴──────┐ ┌───┴─────┐ ┌──┴──────┐
        │        │   │  disk   │ │graphics │ │ network │
        └────────┘   │controller│ │controller│ │interface│
                     └──┬────┬──┘ └────┬────┘ └────┬────┘
                    ┌───┴┐ ┌─┴──┐ ┌────┴────┐      │
                    │disk│ │disk│ │graphics │   ╱ Network
                    └────┘ └────┘ └─────────┘
```

Architecture vs Microarchitecture

↳ Processor architecture:
- Functional appearance to software (ISA) → in this case, compilers!
  - Exactly what instructions does it have?
  - Number of memory/storage locations it has
  - Interface!

↳ Processor microarchitecture:
- Logical structure that implements the architecture
  - Number of functional units, interconnection, control
  - Size of the caches
  - Not visible to the software
  - Implementation!

Memory Hierarchy:

- CPU ⎤ → processor
- CPU Cache ⎦
- Physical Memory → RAM
- Solid State Memory → SSD/USB stick
- Virtual Memory → hard drive

Speed   Cost   Size