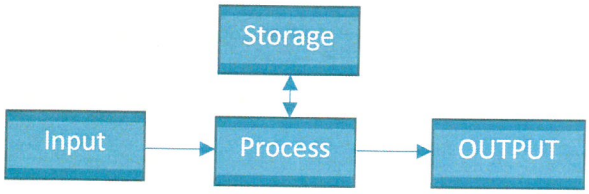
1.1 System Architecture

To be a system the device must have an input, must process that input, and output some result. Some systems have storage.

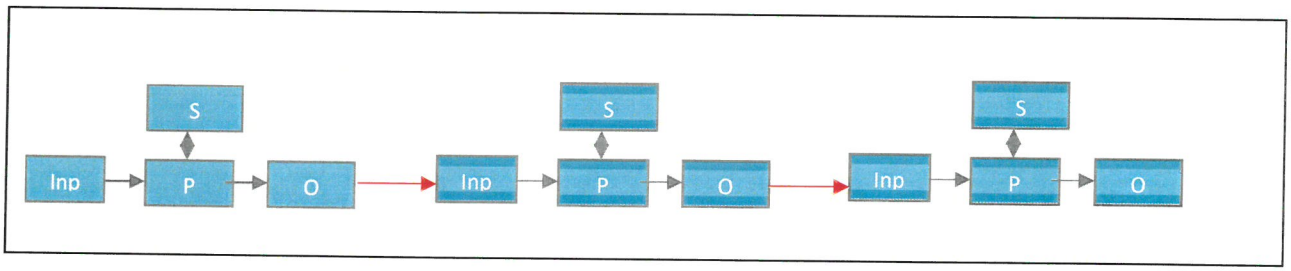
A diagram of a system looks like the following **model:**



Various Systems Exist:

Dedicated System – Does one or two specific tasks i.e. calculator

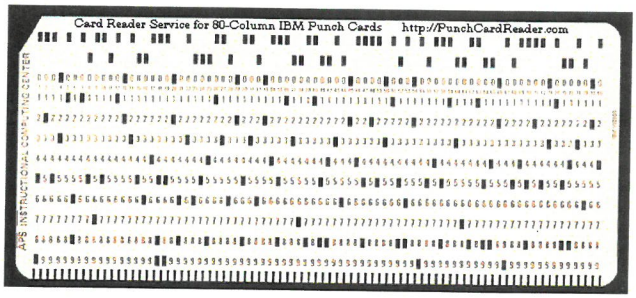
Embedded system – A system (input/process/output) that is part of a larger system i.e. central heating sensor. The red arrows below show the separate systems that do something, which make the completed system.



General system – a system that is capable of running many different programs. I.e. phone/Laptop

Before Von Neumann Architecture

Historically, computer instructions (programs) were stored on cards with holes in, (instructions) and the machines had to be rebuilt with different connections every time the user wanted to run a different program.



An early computer punch card.

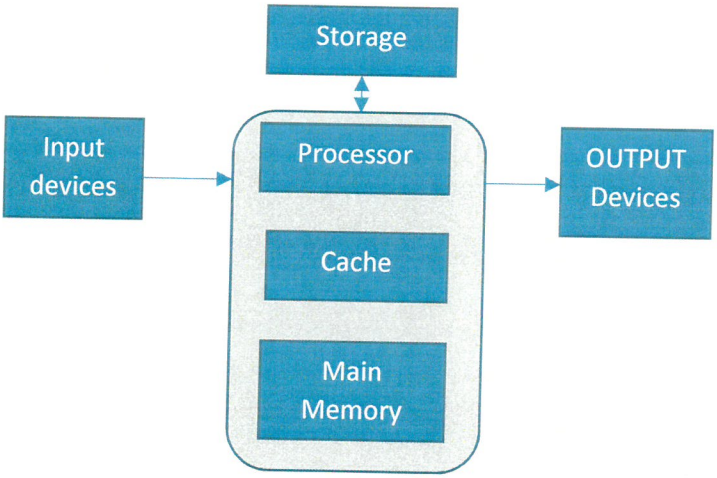
You may have seen the film "The imitation game" which depicts Alan Turin trying to decipher the German Enigma machines in WW2. He was physically having to move wires and valves around inside the machine which was as big as a large room.

Jon Von Neumann came up with a better system in the 1940's whereby all data AND instructions would be stored on the same machine.

His principle was

- All programs (instructions) / data would be stored on the same machine **and in Binary format** (replacing cards with programs on to the programs being stored in Binary in Memory)

His system developed the system model to become:



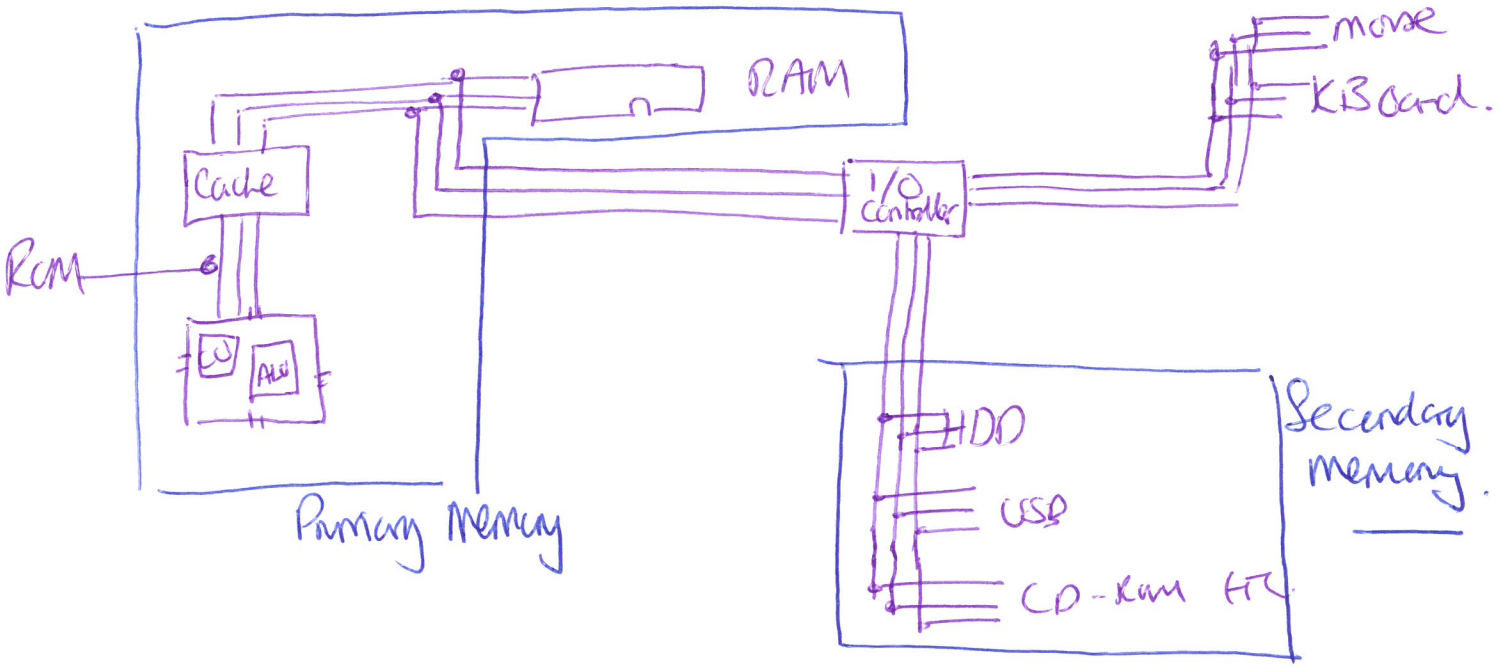
It's worth bearing in mind there are two types of programs that systems can run:

- **Fixed programs** – the program never changes, i.e. a calculator system
- **Stored programs** – the program is stored in RAM and capable of being changed.

It is the **STORED** program machines (systems) that Von Neumann came up with his idea for the memories and architecture of the system. It was to be known as the **Von Neumann Architecture**.

An actual Von Neumann system has a **processor, Cache, and main Memory (RAM)**

Sketch the system architecture outlining difference between primary and secondary memories.



Primary Memory – ROM / RAM / CACHE / Processor Registers Can be accessed directly by the processor

Secondary Memory. HDD (SSD/MAG) / USB / DVD / CD-ROM

Cannot be accessed directly by the processor, and is interfaced by an input/output controller. Slower to access.

CPU, CORE, Processor all mean the same component.

<u>What affects CPU performance?</u>

- Size of Cache
- Speed of core (Hz)
- Number of cores

The characteristics of the CPU are that it works in a fetch decode execute cycle, which is outlined more below.

Processor is made up of the following elements

1. **Cache**

2. **ALU – Arithmetic Logic Unit**
   - / //* - + %
   - NOT AND OR

3. **CU – Control Unit**
   - Provides timing for the instructions to be carried out (measured in Hz)
   - Sends to/receives control signals from other devices
   - Fetches and decodes the instructions in sequence

4. **Processor Registers (memory locations in the Processor itself)**
   - **PC – Program Counter** - Stores the ADDRESS of the next instruction in sequence to be executed (CU)
   - **MAR – Memory Address Register –** stores the memory address from where the next instruction/data will be fetched from, or sent to (CU)
   - **MDR – Memory Data register** stores the actual data/instruction from the location in the MAR (ALU)
   - **CIR – Current instruction Register** stores the instruction about to be decoded (CU)
     - Anything placed in CIR is also copied to Cache
     - Once instruction in CIR is decoded the PC is incremented
     - A further get from memory maybe required before this instruction is finished
     - CIR executes instruction
     - Moves Data to ACC if needed
     - and system repeats starting with new incremented PC value
   - **ACC – Accumulator –** stores the results of any ALU calculations if needed (ALU)

Each move of data/instruction i.e. from PC to MAR from MAR to MDR occurs on one tick/pulse of the clock cycle, i.e. at 1 Hz.

Busses.

Information is moved around on wires called busses. The busses carry the electrical pulse.

There are 3 main busses:

- **Address bus** – carries the address from processor to memory
- **Data Bus** – carries data from processor to memory and vice versa
- **Control Bus** – Carries control Signals to coordinate all the systems activity.

Programs are loaded into memory and the PC is given the start address of the first instruction, then incremented for subsequent instructions after the data is loaded into the MDR.

Draw and label a CPU system, annotate the difference between Primary and secondary memory, deconstruct and label the processor sections, include all memories RAM ROM, CPU (CU& ALU), State differences in secondary storage HDD's