CS47 - Lecture 01

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- Topics
  - Introduction to computer
  - Arithmetic & Logic Unit (ALU)

What is a computer? ...

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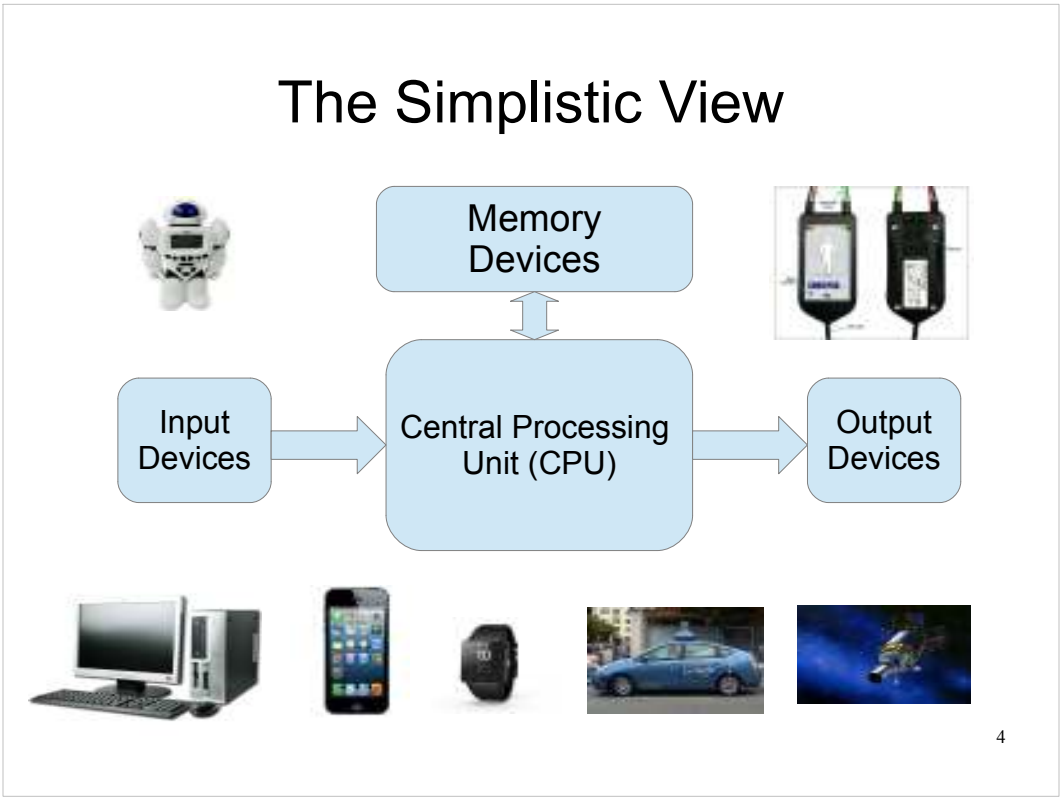
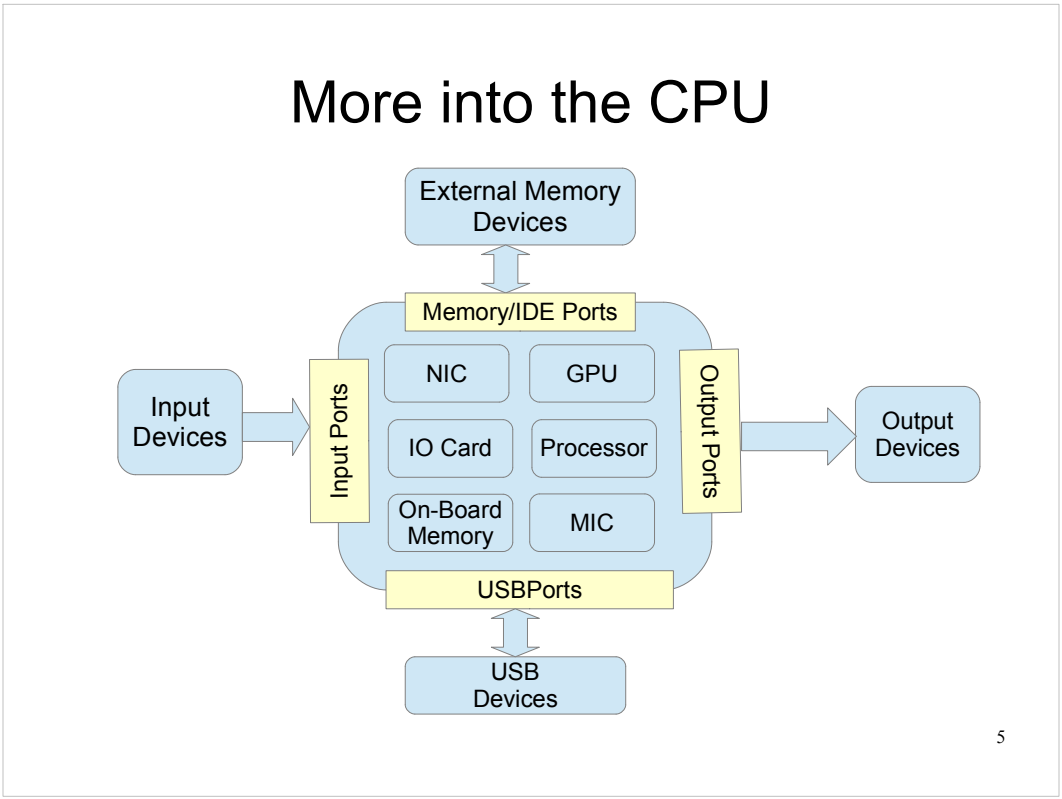
Different 'avatar' of computer

- Lexically 'computer' is 'what can compute.'
- In today's life computer is omnipresent – from personal gadgets to space exploration, from health related areas to entertainment.
- In early days desktops / PC were pretty much only representative of computer in common life.
- With advent of embedded technology, computer is now an intricate part of our personal as well as professional life.
- From all these different forms and flavors of computers, how can we construct a common blue print which represent pretty much every one of them?



- All of the computer forms can be represented as a very basic diagram having following components.
  - Central Processing Unit (CPU) to precess incoming information.
  - Input Devices (keyboard, mouse, track pad, camera, microphone, sensors, etc.) to acquire incoming information.
  - Output devices (monitor, display, robot arms, printers, speakers, etc.) to manifest the outcome of computation.
  - Memory Devices (main memory, flash drive, hard disk, tape) to store and reuse information.
- Information flows from input devices (new) and memory (stored) into CPU.
- CPU Process the information and send it output devices for immediate use by users and memory for later use.
- Since involving memory storing latest information for later use, computers are state machines.

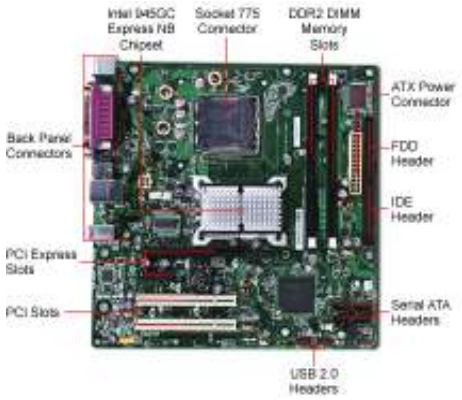


- The CPU may contain multiple parts like Processor (a.k.a. Micro-processor), GPU (Graphics Processing Units), NIC (Network Interface Card), IO Card (Input Output Card), MIC (Memory Interface Card), on board memory, and many more.

- All the external devices are connected to CPU using different types of ports.

- CS47 will concentrate study on the micro-processor, memory and their interaction. It'll also touch a little on the IO operations.

The reality



Motherboard of a Desktop

Motherboard of a Smartphone

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- Placements of each individual components depends on the motherboard specification.
- With a smaller motherboard footprint requirement (e.g. smartphones) some of the components may be placed within single chip implementing SoC (System-on-Chip).

Arithmetic and **L**ogic **U**nit ...

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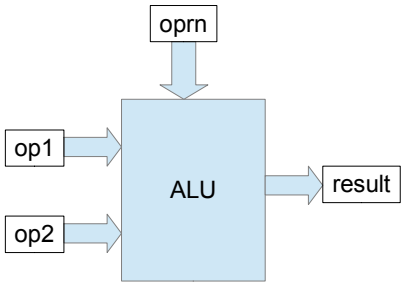
Arithmetic & Logic Unit (ALU)

- Provides the fundamental functionality of a computer.

```
// C-API declaration for function 'ALU'
// Arguments:
//    result: return value by reference
//    op1: First operand
//    op2: Second operand
//    oprn: Operation code as in CS147sec05
//
void  ALU (int &result, int op1,
                int op2, int oprn;
```

```
// C-API definition for function 'ALU'
void  ALU (int &result, int op1,
                int op2, int oprn){
    switch(oprn){
      case 0x20: result = op1 + op2; break;
      case 0x22: result = op1 - op2; break;
      case 0x2c: result = op1 * op2; break;
      case 0x24: result = op1 & op2; break;
      case 0x25: result = op1 | op2; break;
      case 0x27: result = ~(op1 | op2); break;
      case 0x2a: result = (op1<op2)?1:0; break;
      case 0x00: result = op1 << op2; break;
      case 0x02: result = op1 >> op2; break;
      default: // do nothing
    };
    return;
}
```



Interface Diagram for ALU

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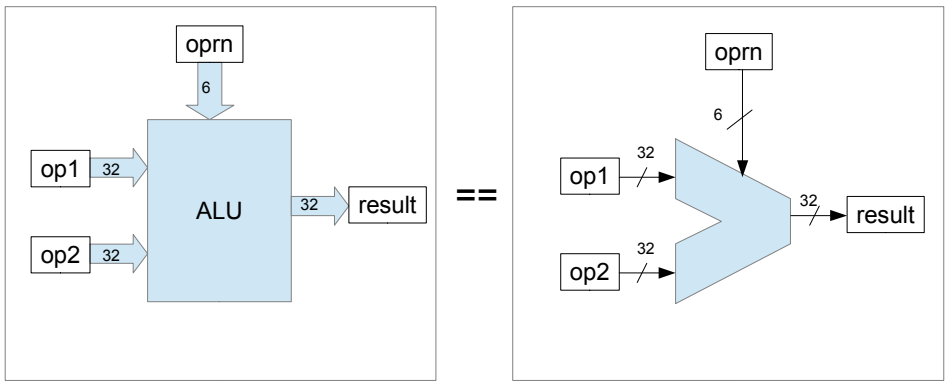
- ALU provides fundamental functionality of a computer. Any complex mathematical and logical program are broken down in terms two operand operations. For example: r = (a+b-c*d) is broken down in to following series of operations by compiler.
  - T1 = c * d
  - T2 = b – T1
  - r = a + T2

Arithmetic & Logic Unit (ALU)

- As a computer architectural object, ALU is represented in a very special object shape.



Interface Diagram for ALU

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- Being a computer architectural object, it is necessary to include operation width. In our case it is 32 bit.
- Multiple bits are represented with single strike line indicating that the operations involves multiple bits. Plain line connection denotes single bit operation.
- The arrow indicates the direction of data flow – input, output or both ways.

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