Welcome to CS220: Computer Organization

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Sketch

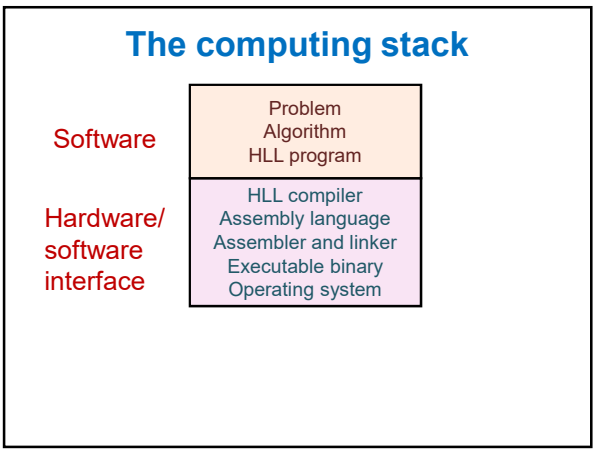
- The computing stack
- Anatomy of a computer system

The computing stack

The computing stack

Software

Problem
Algorithm
HLL program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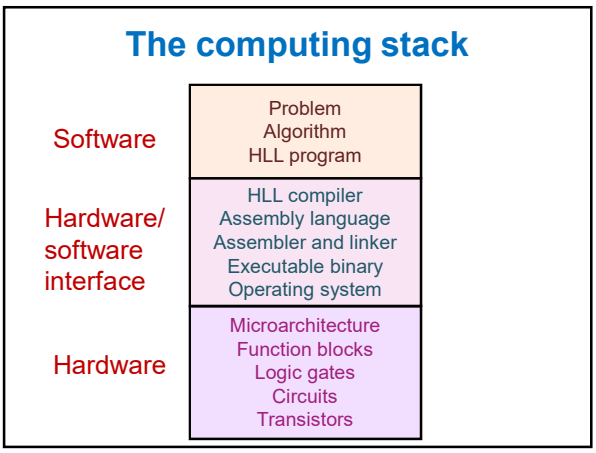
HLL program
Hardware/
software
interface
HLL compiler
Assembly language
Assembler and linker
Executable binary
Operating system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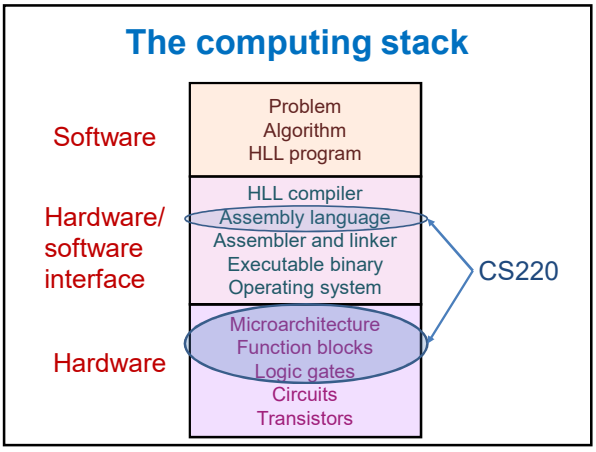
Hardware
Microarchitecture
Function blocks
Logic gates
Circuits
Transistors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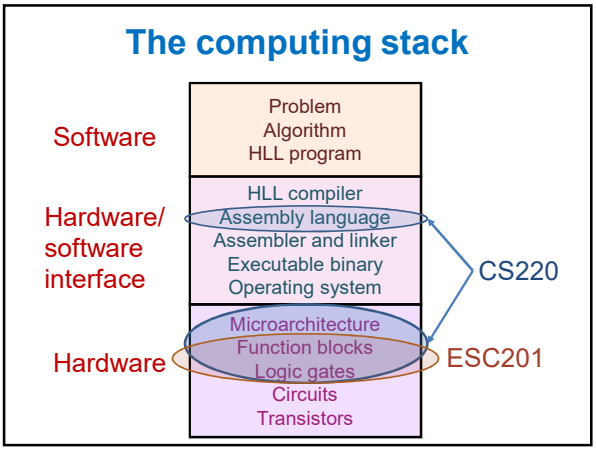
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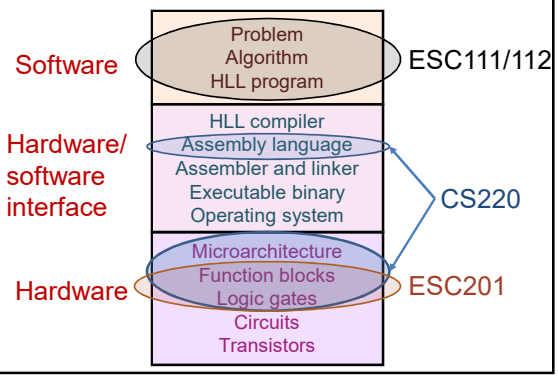
The computing stack



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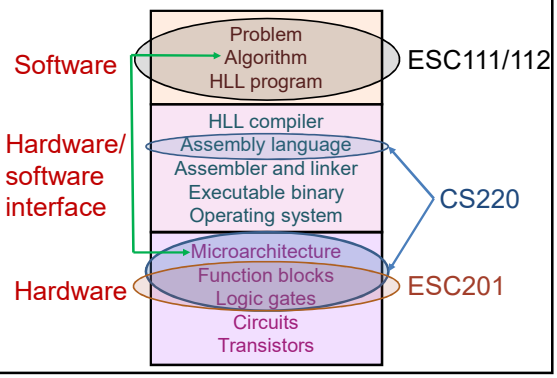
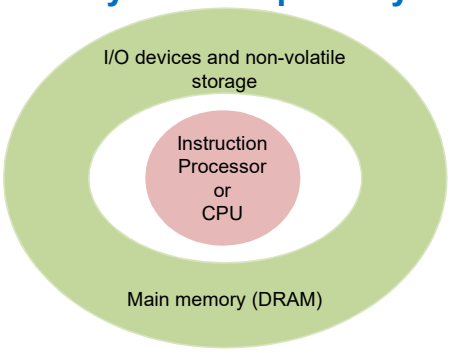


Logic gates to microarchitecture

- Example of a ripple-carry adder
  - Logic gates for building a function block for adding two bits with a carry input
    - Known as a full adder
  - An array of full adders used to design the microarchitecture of an adder
    - Encapsulates an algorithm for adding two n-bit numbers
    - A microarchitecture is always linked to an underlying algorithm for executing the task
- A digital computer represents one of the most complex pieces of microarchitecture
  - A complex algorithm implemented in hardware

Anatomy of a computer system



Anatomy of a computer system

- The central processing unit (CPU)
  - Also known as microprocessor
  - Dictates how a task will be done, but cannot do anything on its own
  - Needs to be told what to do next in the form of a stream of "instructions"
    - These instructions are generated from a program that represents an algorithm for accomplishing the task
  - Can store intermediate/final results of a computation in main memory
    - Dynamic random access memory (DRAM); volatile
  - Can store information on persistent non-volatile storage media e.g., magnetic hard disk

Anatomy of a computer system

- Peripheral I/O devices
  - Plug-ins to the CPU for communicating with the world
  - Display (CRT, LCD, touchscreen)
  - Keyboard
  - Mouse
  - DVD reader/writer
  - Speaker
  - Microphone
  - Camera
  - Wireless communication
  - Wired Ethernet communication

Anatomy of a computer system

- How does an instruction execute inside the processor?
  - Every entity residing inside a computer has an address
    - An instruction also has an address
  - The processor maintains the address of the next instruction in a register called program counter
  - The instruction is fetched from main memory and placed in an instruction register
  - The instruction is decoded to generate the control signals for executing the instruction
    - Send to adder if this is an addition instruction

Anatomy of a computer system

- How does an instruction execute inside the processor?
  - Most instructions require source operands for execution
    - a+b
  - After decoding the instruction, the operands are fetched
    - Operand addresses are typically encoded in the instruction or could be implicit
    - These addresses are known after decoding the instruction
  - The instruction can now execute
    - Operands are sent to the adder

Anatomy of a computer system

- How does an instruction execute inside the processor?
  - Most instructions generate a result
    - c=a+b
  - The address of the result (or destination) operand is typically encoded in the instruction or implicit
    - This address is known after decoding the instruction
  - The result is stored in the destination operand location

Anatomy of a computer system

- How does an instruction execute inside the processor?
  - The execution of an instruction requires the appropriate control and data paths to be activated
- Data path is usually slow because main memory is much slower than the processor
  - Commonly used optimizations for speeding up the data path:
    - Reasonably large set of general-purpose registers inside the processor
    - Fast memory (known as cache) inside the processor