CEng 240 – Spring 2021
Week 1

Sinan Kalkan

Introduction,
Basic Computer Organization

Disclaimer: Figures without reference are from either from "Introduction to programming concepts with case studies in Python" or "Programming with Python for Engineers", which are both co-authored by me.

This Week

- Introduction
  - Course content, objectives, outline; Grading; Information about the homeworks, the labs, the exams.
- Basic computer organization:
  - What is computing, programming
  - Von Neumann Architecture, CPU & Memory
  - Fetch, decode, execute cycle
  - Machine code + assembler
  - BIOS, OS

Introduction to the Course

https://ceng240.github.io/

- Objectives
  - This course gives a brief introduction to a working understanding of basic computer organization, data representation, programming language constructs, and algorithmic thinking. It is designed as a first course of programming and supported by laboratory sessions for students outside of the Computer Engineering major.
- Textbook
  - *Programming with Python for Engineers,* by S. Kalkan, O. T. Şehitoğlu and G. Üçoluk. Available at: https://pp4e-book.github.io/
- Course conduct
  - Weekly pre-recorded lectures released before the week.
  - 2-hour live sessions with instructors.
  - Office hours with the assistants.
  - Lab exams.
  - Midterm exam and final exam.

Introduction to the Course

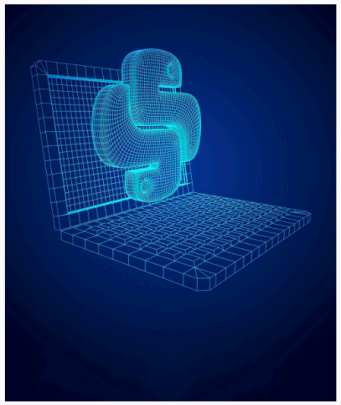
https://ceng240.github.io/

Grading

Midterm	30%
Labs	30%
Participation	5%
Final	35%

- Contact
  - 2xx@ceng.metu.edu.tr
- Office hours
  - Email me for an appointment (skalkan@metu.edu.tr)
  - If there is significant interest, I can arrange a regular office hour session.

The book is interactive and available in Colab, HTML and PDF.
https://pp4e-book.github.io/



Programming with Python for Engineers

An **interactive** book introducing Python to engineers and engineering students.

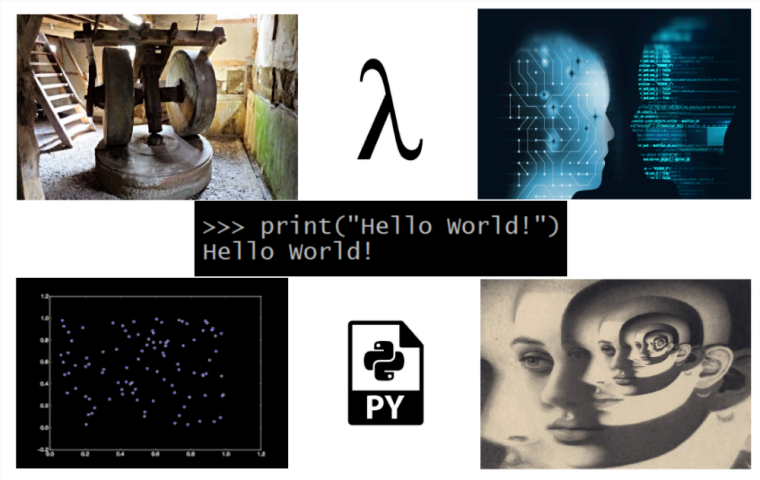
The writing of the book is still ongoing and there may be updates.

All comments and updates welcome. See how you can contribute.

Disclaimer: The PDF version is automatically generated and may include errors. Prefer HTML or Colab versions for the time being.

The workbook in a similar format. https://pp4e-workbook.github.io/

The Workbook for Programming with Python for Engineers



The workbook accompanying the Programming with Python for Engineers book is presented here. Supplementary exercises for each chapter will be available in due course.

BASIC COMPUTER ORGANIZATION

What is computing?

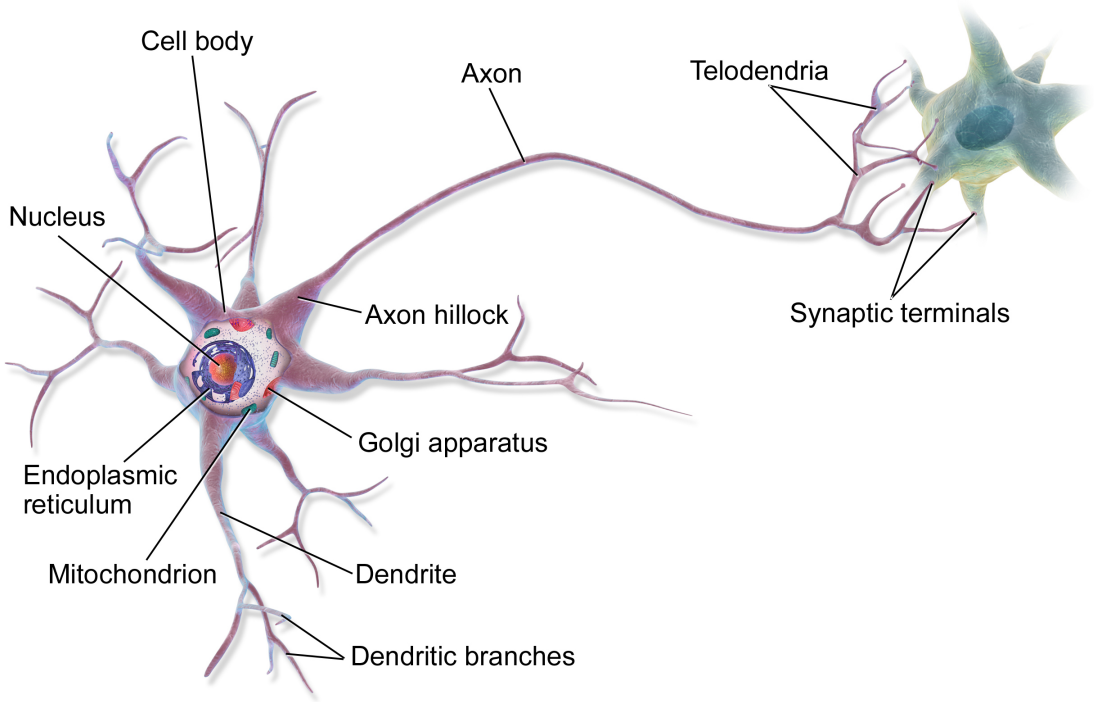
- From the book:
  - “Computing is the process of inferring data from data. What is going to be inferred is defined as the task. The original data is called the input (data) and the inferred one is the output (data).”

What is a computer?

- **The most common context**: An electronic device that has a ‘microprocessor’ in it.
  - Binary
- **The broader context**: Any physical entity that can do ‘computation’.

https://en.m.wikipedia.org/wiki/File:Computer_from_inside_018.jpg

What is a computer?

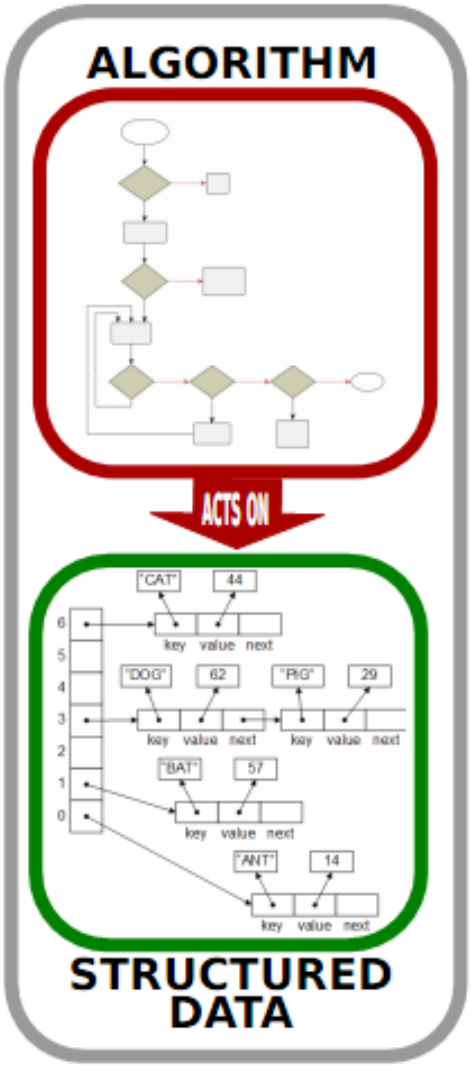


[Drawing by BruceBlaus - Own work, CC BY 3.0, https://commons.wikimedia.org/w/index.php?curid=28761830]

What is programming?

WORLD PROBLEM

TRANSFORMED



IMPLEMENTED

```
int alice = 1
int bob = 456,
int carol;
main(void)
{
 carol = alice*bob;
 printf("%d", carol);
}
```

PROGRAM

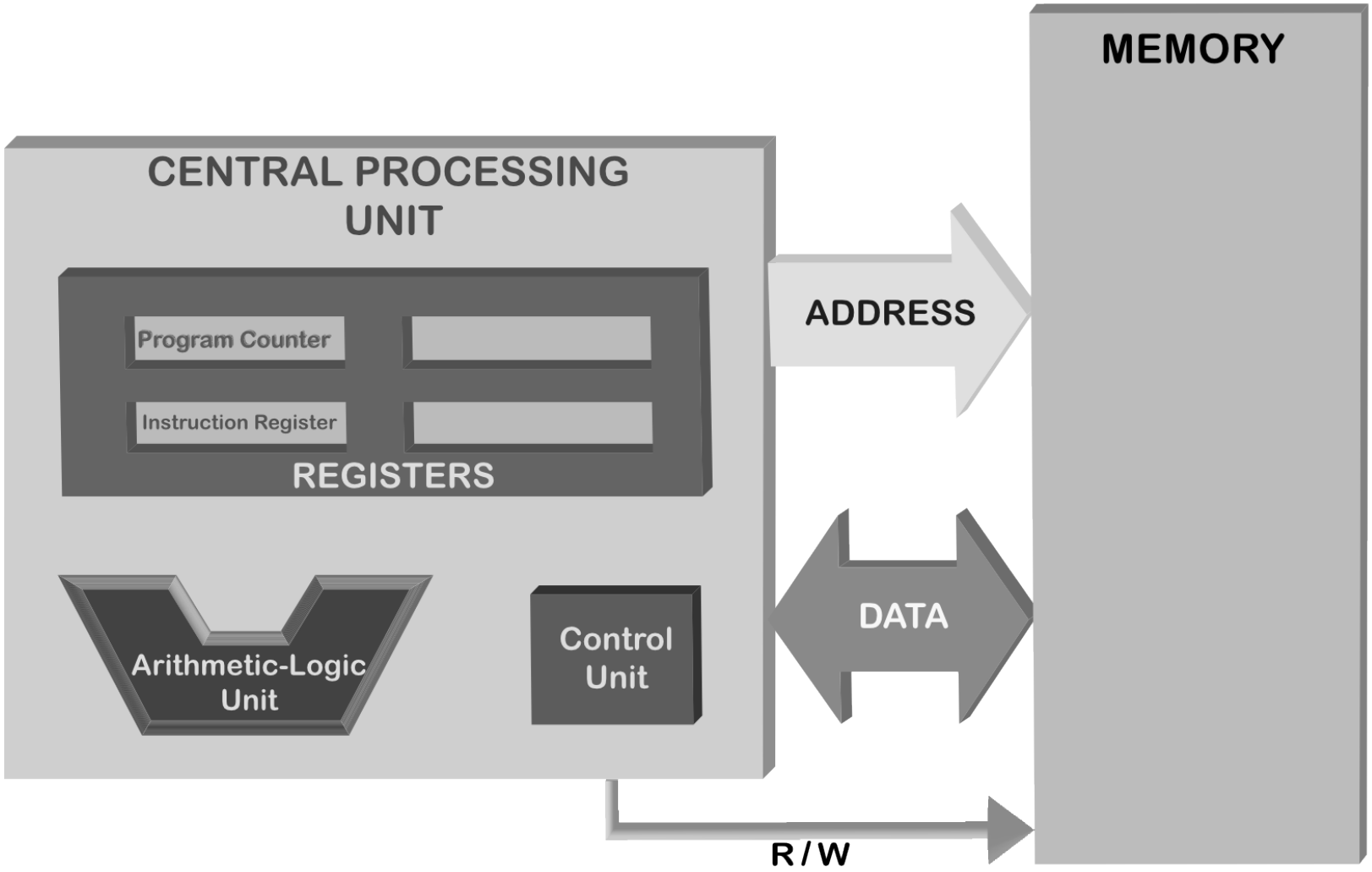
What is a programming?

- Program:
  - “a series of steps to be carried out or goals to be accomplished”
- A recipe for cooking a certain dish is also a program (but not a computer program).

What is programming?

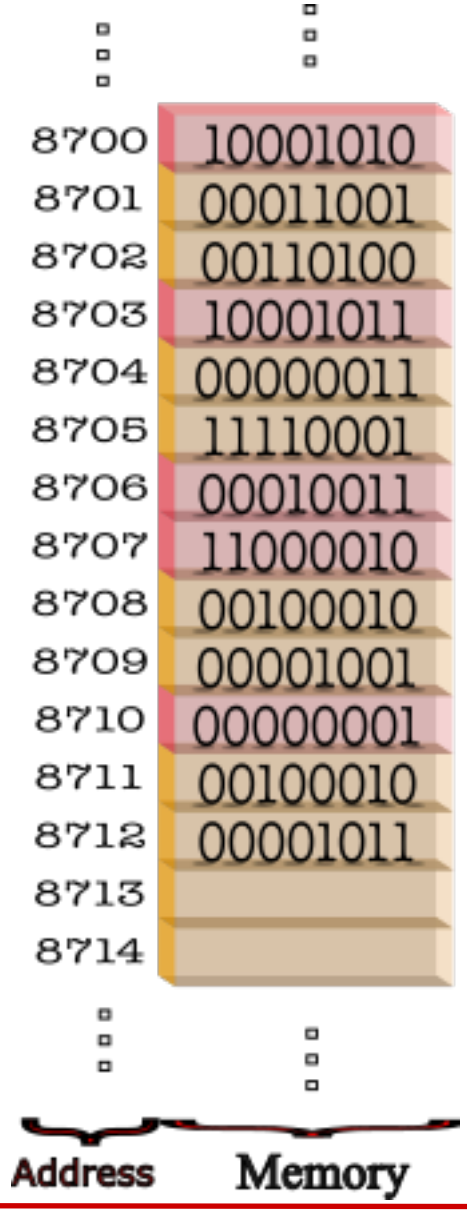
https://www.youtube.com/watch?v=Ct-lOOUqmyY

Von Neumann Architecture

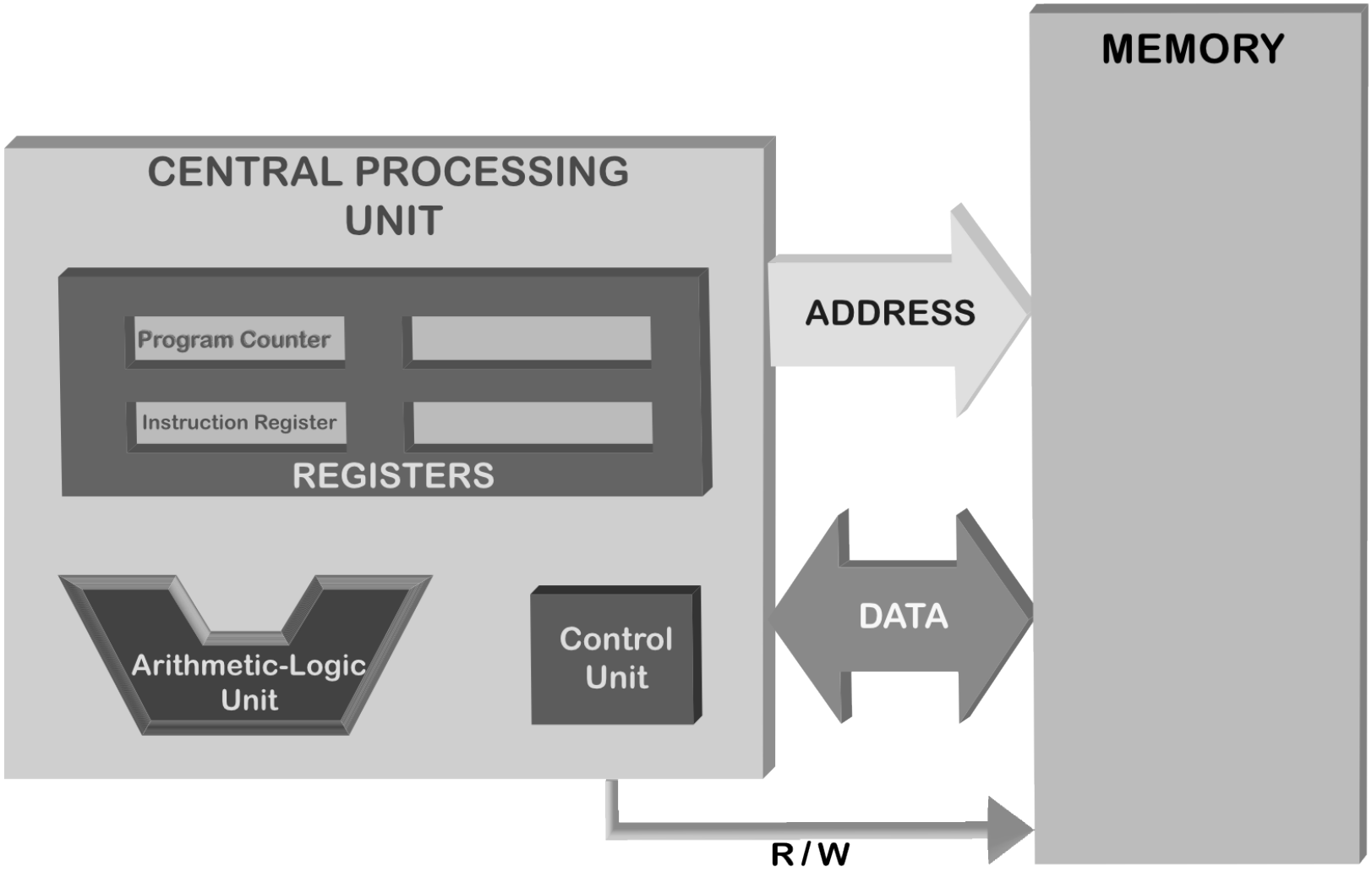


Memory

- Random Access Memory (RAM)
- Allows reading and writing operations
- Each access requires an address

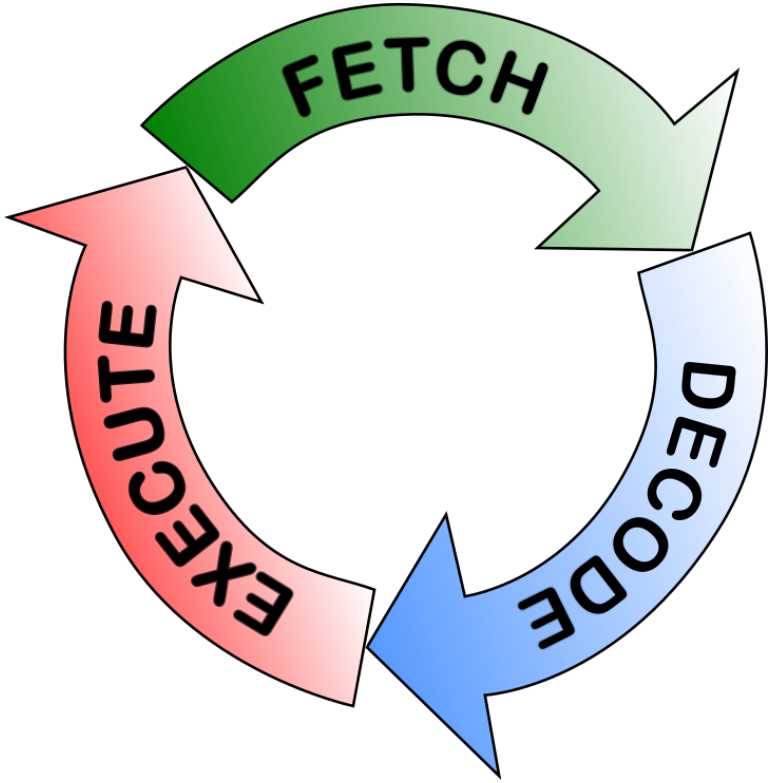


Central Processing Unit



Fetch, decode, execute cycle

- Fetch
  - Retrieve the next instruction from the memory
- Decode
  - Look at the opcode of the instruction and decode what actions should be performed.
- Execute
  - Execute the actions identified in the decode phase.



Stored Program Concept

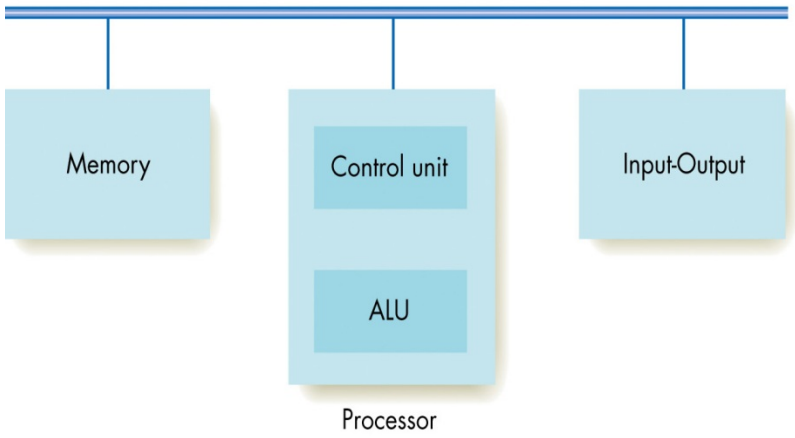
```
01010101 01001000 10001001 11100101 10001011 00010101 10110010 00000011
00100000 00000000 10001011 00000101 10110000 00000011 00100000 00000000
00001111 10101111 11000010 10001001 00000101 10111011 00000011 00100000
00000000 10111000 00000000 00000000 00000000 00000000 11001001 11000011
...
11001000 00000001 00000000 00000000  00000000 00000000
```

```
main:
        pushq   %rbp
        movq    %rsp, %rbp
        movl    alice(%rip), %edx
        movl    bob(%rip), %eax
        imull   %edx, %eax
        movl    %eax, carol(%rip)
        movl    $0, %eax
        leave
        ret
alice:
        .long   123
bob:
        .long   456
```

```
int alice = 123;
int bob = 456;
int carol;
main(void)
{
  carol = alice*bob;
}
```

Peripherals of a Computer

- All input-output devices are connected to the CPU via a wiring system called bus.

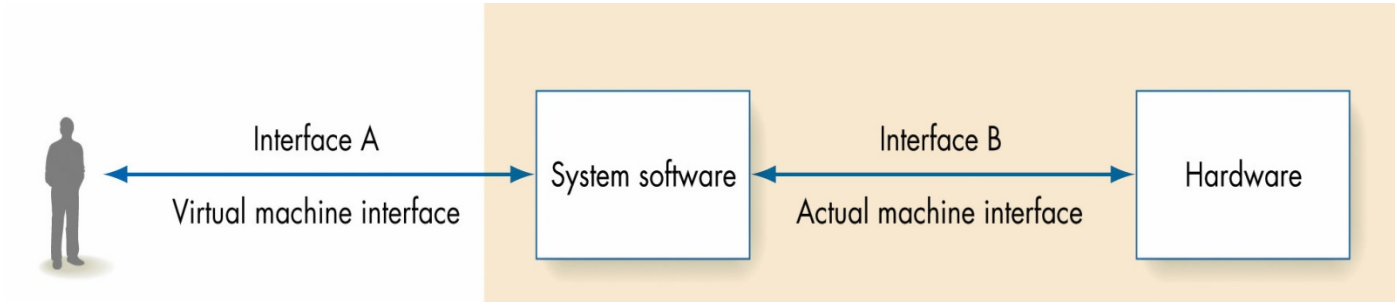


From: “Invitation to Computer Science” book by G. M. Schneider, J. L. Gersting

The running of a computer

- BIOS (Basic Input-Output System) is loaded
- Power-On Self Test (POST) is performed.
  - Checks CPU and RAM for errors
  - Identifies and initializes peripherals
- Looks for an OS through the storage devices
  - Master Boot Record (MBR) of a disk contains a table and code piece for loading the OS on that disk
- MBR is executed to load the OS.
- BIOS and MBR are extended by
  - Unified Extensible Firmware Interface
  - GPT (GUID Partition Table)

OS



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- Memory management
- Process management
- Device management
- File management
- Security
- User interface

Final Words: Important Concepts

- Computer, computing, programming.
- The von Neumann Architecture.
- The interaction between the CPU and the memory via address, R/W and data bus lines.
- The crucial components on the CPU: The control unit, the arithmetic logic unit and the registers.
- The fetch-decode-execute cycle.
- The stored program concept.
- Operating system and its responsibilities.

Final Words: Reading

- The material at the end of the first chapter.
- History of computing:
  - http://www.computersciencelab.com/ComputerHistory/History.htm
  - https://www.youtube.com/playlist?list=PL1331A4548513EA81

THAT'S ALL FOLKS!
STAY HEALTHY