ELEC1601

Introduction to Computer Systems

Why are you here?

Why are you here?

- You have no choice…
    - It is a core unit

Why are you here?

- You want to understand how computers work
  - Not how to use MS Word/send email…

Why are you here?

- You want to understand how computers work
  - Not how to use MS Word/send email…

- What is inside a computer
- How could you design your own computer
  - Make the best better
- How does a computer ‘talk’ to other devices
  - Hardware vs software
- How do you use a computer efficiently

What is involved in understanding computers

- You may already have your favourite programming language
  - You are talking to them

- But circuit only understands 0’s and 1’s
  - We will learn how to bridge the gap

Why do people like this course?

- You want to understand how computers work

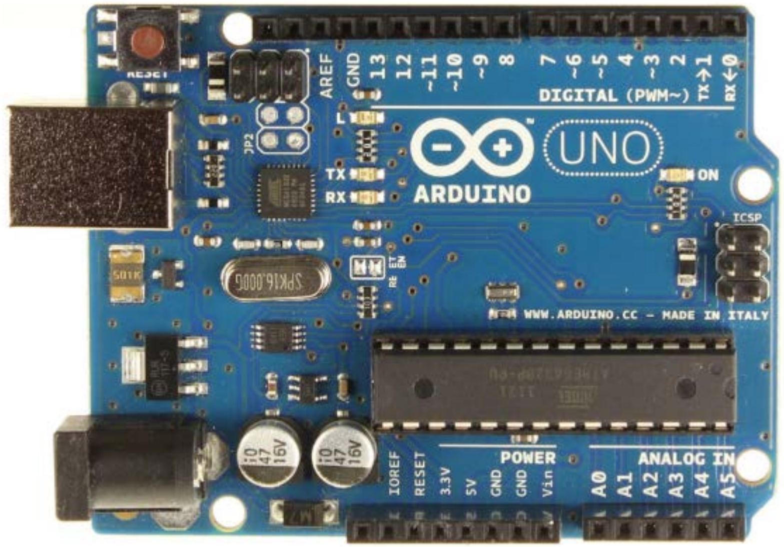
Why do people like this course?

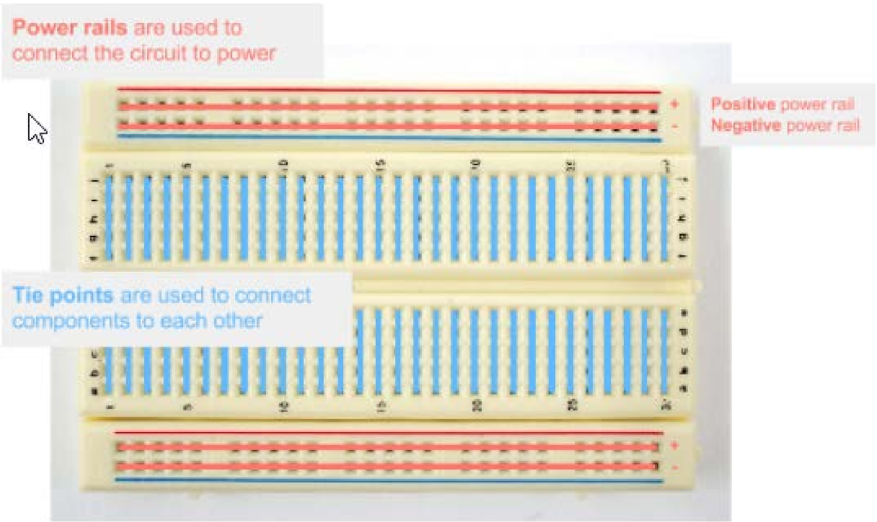
Why do people like this course?

- You want to understand how computers work
- Fun
- Practical

Fun/Practical

- Learn how to control a real-chip
- We use an Arduino
  - You should build skills and methodologies to talk to any computer




Power rails are used to connect the circuit to power

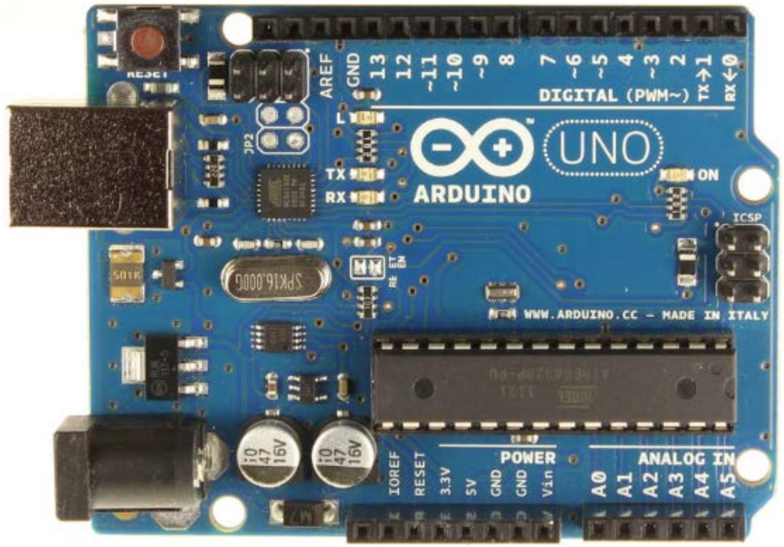
Positive power rail
Negative power rail

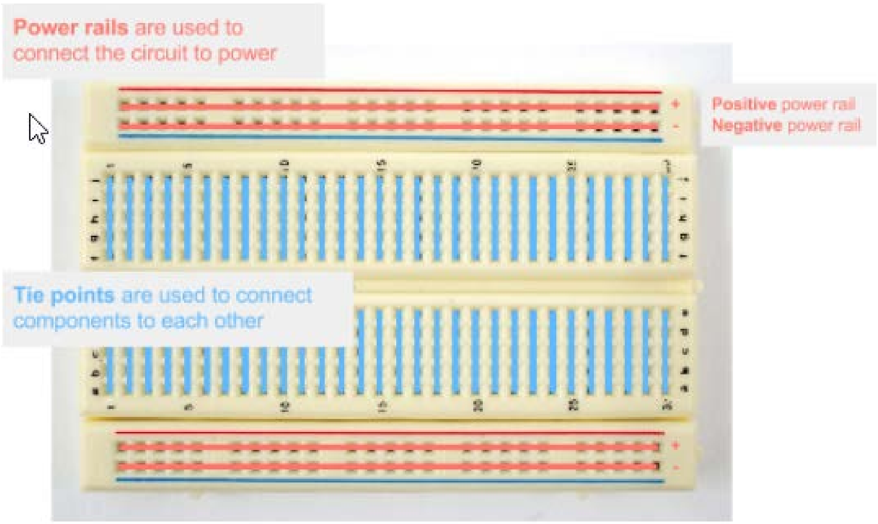
Tie points are used to connect components to each other

Fun/Practical

- Learn how to control a real-chip

- We use an Arduino
  - You should build skills and methodologies to talk to any computer

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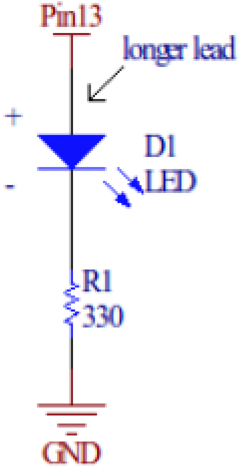
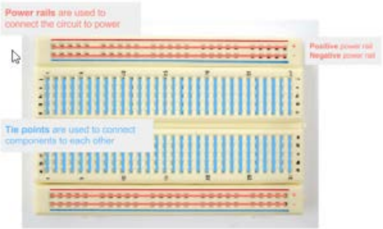
Positive power rail
Negative power rail
Tie points are used to connect components to each other

Fun/Practical (e.g. lab1)

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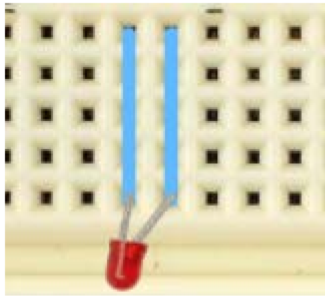
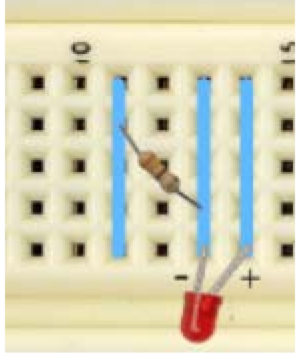
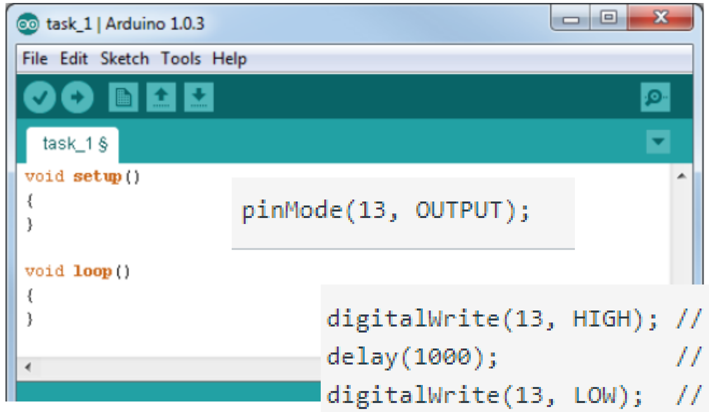




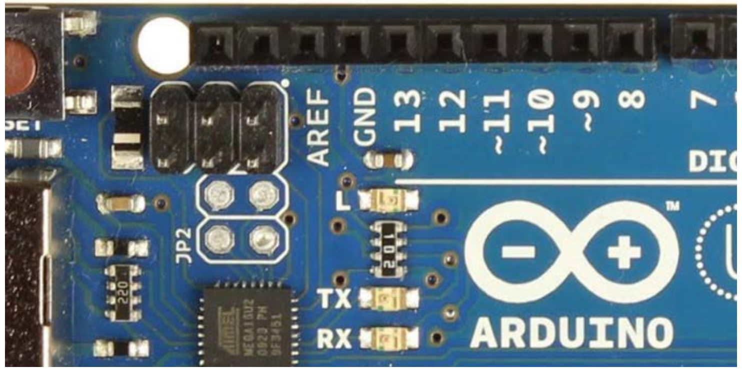


```
void setup()
{
}

void loop()
{
}
```

```
pinMode(13, OUTPUT);
```

```
digitalWrite(13, HIGH); // turn the LED on
delay(1000);            // wait for a second
digitalWrite(13, LOW);  // turn the LED off
delay(1000);            // wait for a second
```



Course scenario

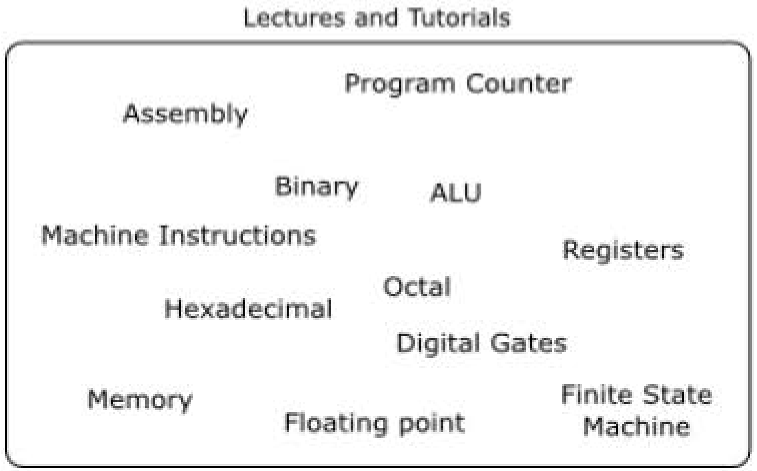
- We just bought one of these

- How does it work? How do we use it? How can I use it to achieve something special? What can I connect it to?
- Propose your teams solution to the boss

https://canvas.sydney.edu.au/courses/17907/pages/the-learning-environment?module_item_id=577646#course-scenario

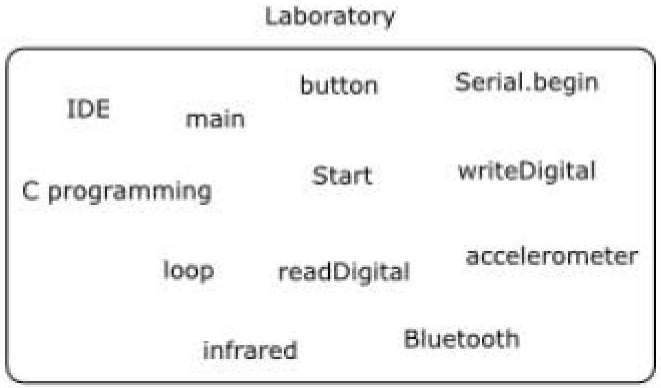
Course scenario

- Lectures
  - Understand circuit/architecture
- Lab
  - Program it bottom up



Lectures and Tutorials

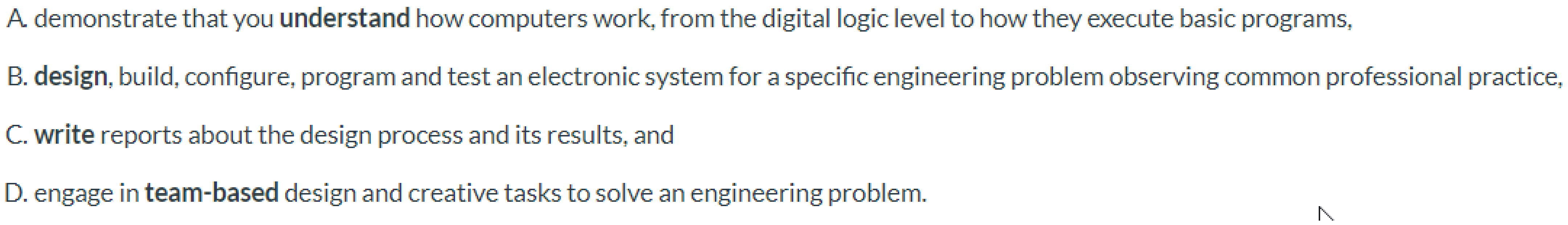
Program Counter
Assembly
Binary
ALU
Machine Instructions
Registers
Octal
Hexadecimal
Digital Gates
Finite State Machine
Memory
Floating point



Laboratory

Serial.begin
button
IDE
main
Start
writeDigital
C programming
accelerometer
loop
readDigital
Bluetooth
infrared

Learning Objectives



A. demonstrate that you **understand** how computers work, from the digital logic level to how they execute basic programs,

B. **design**, build, configure, program and test an electronic system for a specific engineering problem observing common professional practice,

C. **write** reports about the design process and its results, and

D. engage in **team-based** design and creative tasks to solve an engineering problem.

- Content should always be linked to these objectives
- We are here to help you achieve

Additional Learning Objectives

- We want to help you to learn how to learn

- What are your learning strategies?

Strategies for sophisticated learners

- Why?
- What does an engineer do?

Strategies for sophisticated learners

- Why?
- What does an engineer do?
    - Solve problems

- What does an engineer need to be able to do this?

Strategies for sophisticated learners

- Why?
- What does an engineer do?
    - Solve problems
- What does an engineer need to be able to do this?
    - Learn by themselves
    - Calm under uncertainties

Strategies for sophisticated learners

- You are going to run a marathon

Strategies for sophisticated learners

- How did you study for your HSC/VCE/IBAC/A-levels?
- What was the single most effective thing you did?

Strategies for sophisticated learners

- Example learning strategy
    - Lectures
        - Attend
    - Tutorials
        - Attend
        - Do exercises as instructed by tutor
    - Labs
        - Attend
        - Complete as much as possible during lab session
        - Write lab report afterwards
    - Exam
        - Study during STUVAC
            - Make sure you complete all past lecture quizzes
        - Extra last minute study before relevant exam
        - Go to any ‘exam consultation sessions’ organised by lecturer

Strategies for sophisticated learners

- We want you to experience new options that can potentially help you to learn better.

Dual-process theories of reasoning

- Brain processes in two ways
- System 1:
    - Intuitive/instantaneous
        - Walk down street
        - What is 2+2?
    - Effortless
- System 2:
    - Invoked when system 1 fails to solve problem
    - Tries to create a rational answer

- You are not learning when you are using system 1

A better learning strategy

- Lectures
  - Prepare for lectures
    - Not at the last moment
      - Distributed practice better
  - Attend
  - Participate diligently/actively
    - Be willing to make mistakes
- Tutorials
  - Prepare for lectures
  - Attend
  - Do exercises as instructed by tutor
    - Participate diligently/actively
    - Be willing to make mistakes
  - Be willing to get ahead/go beyond/ask tutor more questions

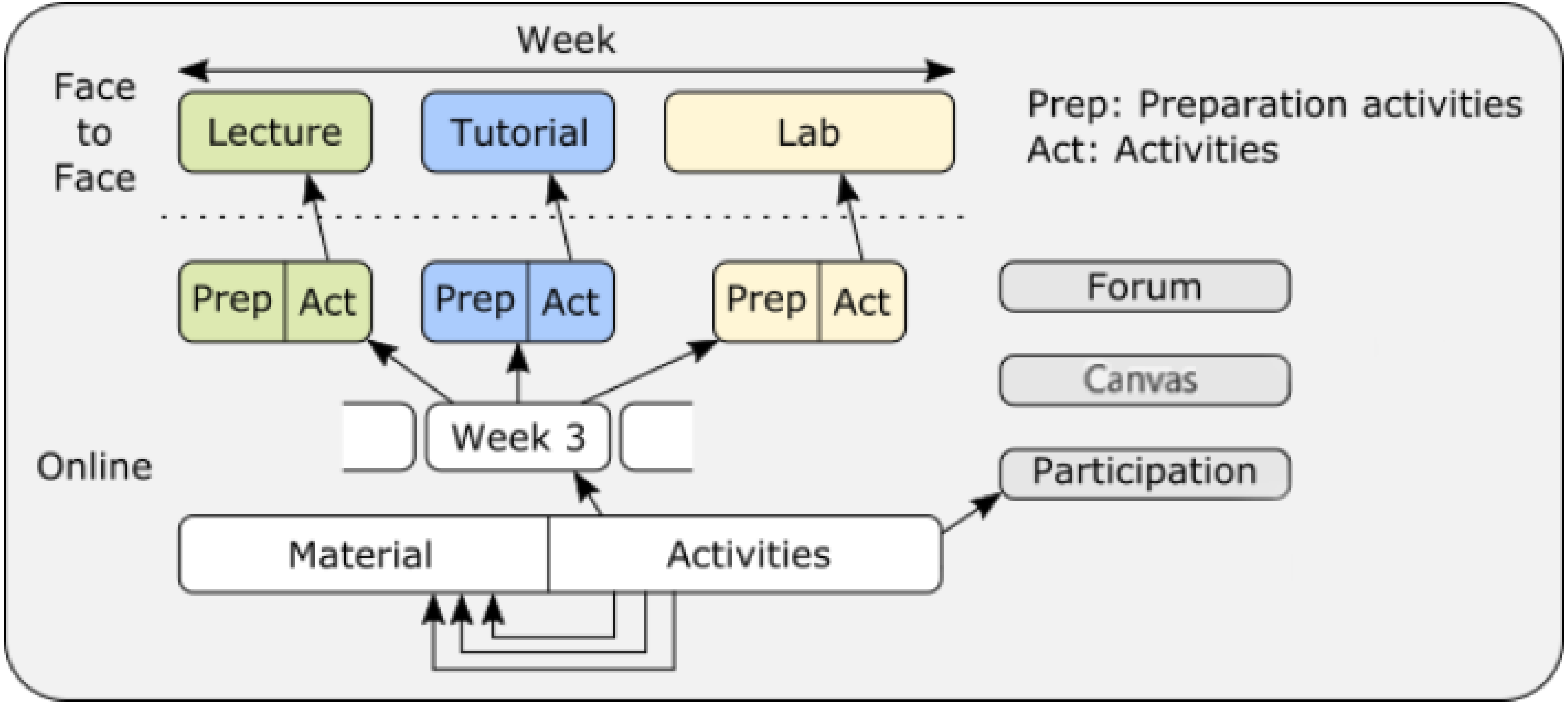
A better learning strategy

- Labs
  - Prepare for lab in advance
  - Attend
  - Complete as much as possible during lab session
  - Build your team
  - Use the demonstrators
  - Write lab report afterwards

A better learning strategy

- Exam
  - Study throughout semester
  - Have a study plan for exam period starting during STUVAC
    - Make sure you complete all past lecture quizzes
      - DO NOT DEPEND ON THIS
  - Extra last minute study before relevant exam
  - Go to any ‘exam consultation sessions’ organised by lecturer
    - Only if they can help you
  - Use your friends
  - Use the discussion forum

Learning strategies



Learning strategies

- We want you to prepare before a lecture.
  - Really? Why?

Learning strategies

- We want you to prepare before a lecture.
    - Really? Why?
    - So you can work in lecture
        - Active participation
        - Talk to partners.
- Lectures only contain a subset of the information in Canvas.

Learning strategies

- Tutorials should follow lectures
  - You are introduced to ideas, but build on it in tutorials.
  - Harder questions
  - More help

Learning strategies

- Labs arguably separate
  - More practical
    - But it should all come together at the end

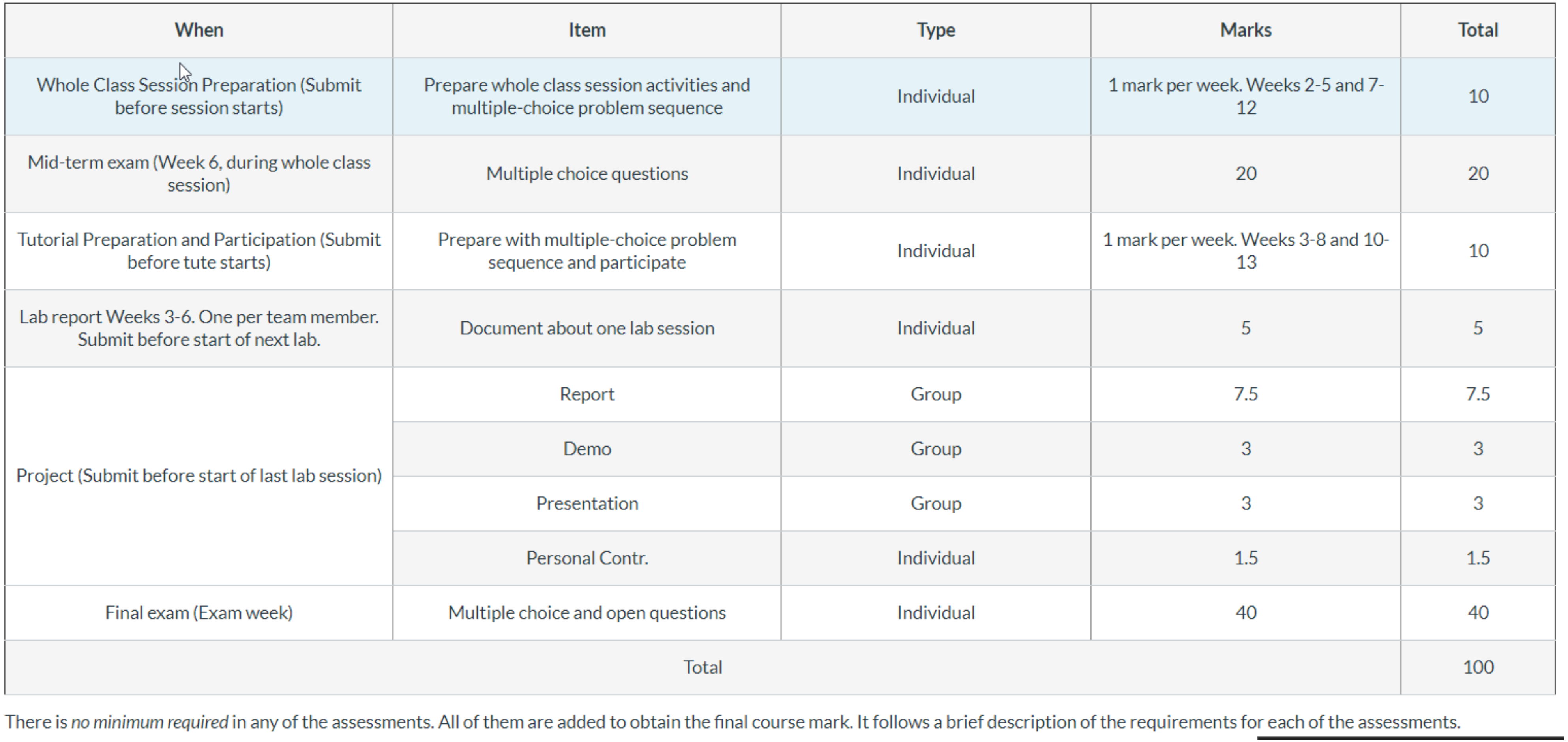
Bureaucratic stuff

Your life for this course

- https://canvas.sydney.edu.au/

- (https://canvas.sydney.edu.au/courses/17907)

How do I pass?



When	Item	Type	Marks	Total
Whole Class Session Preparation (Submit before session starts)	Prepare whole class session activities and multiple-choice problem sequence	Individual	1 mark per week. Weeks 2-5 and 7-12	10
Mid-term exam (Week 6, during whole class session)	Multiple choice questions	Individual	20	20
Tutorial Preparation and Participation (Submit before tute starts)	Prepare with multiple-choice problem sequence and participate	Individual	1 mark per week. Weeks 3-8 and 10-13	10
Lab report Weeks 3-6. One per team member. Submit before start of next lab.	Document about one lab session	Individual	5	5
Project (Submit before start of last lab session)	Report	Group	7.5	7.5
	Demo	Group	3	3
	Presentation	Group	3	3
	Personal Contr.	Individual	1.5	1.5
Final exam (Exam week)	Multiple choice and open questions	Individual	40	40
Total				100

There is *no minimum required* in any of the assessments. All of them are added to obtain the final course mark. It follows a brief description of the requirements for each of the assessments.

https://canvas.sydney.edu.au/courses/17907/pages/course-organisation?module_item_id=577645

How do I pass?

- Why marks for lecture/tutorial preparation?
  - How do I get them?
  - What if I am late?
- Lab reports (weeks 3-6)
  - One per team member. Submit before start of next lab
  - Up to two team members can submit
  - Teams of 4

How do I pass?

- Why marks for lecture/tutorial preparation?
  - How do I get them?
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- Lab reports (weeks 3-6)
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  - Teams of 4
- More lab reports than labs?

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  - Teams of 4
- More lab reports than labs?
  - Engineer allowed to make mistake
    - Fail, can fix later

How do I pass?

- Why marks for lecture/tutorial preparation?
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- Lab reports (weeks 3-6)
  - One per team member. Submit before start of next lab
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- Do I need to join a team?

How do I pass?

- Why marks for lecture/tutorial preparation?
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  - What if I am late?
- Lab reports (weeks 3-6)
  - One per team member. Submit before start of next lab
  - Up to two team members can submit
  - Teams of 4
- Do I need to join a team?
  - Yes

How do I pass?

- Final exam
  - I may have already passed the unit before taking the exam?

How this course is structured/What you need to do each week

- Know what week you are in
  - Do not get behind
  - Do not do the wrong tasks

- https://canvas.sydney.edu.au/courses/17907/pages/week-2?module_item_id=577682

Plagiarism

- Taken very seriously at university

Edstem

- https://edstem.org/courses/3739/discussion/

- Ask questions
- Answer other questions
- Does not matter if your answers are incorrect
  - Discussion will improve them

Electronic Device Strategy

- How good are Apple/Samsung/Huawei Engineers?

- What do you think there goal is?

Electronic Device Strategy

- Can you really multi-task?

- Handwriting or tablet in lectures?

Top 10 Study Techniques

- https://canvas.sydney.edu.au/courses/17907/pages/strategies-for-sophisticated-learners

Back to computers

What is a computer system

What is a computer system

- Something you communicate through keyboard/mouse/touchscreen
- Supporter of apps
- Something that does mass arithmetic instructions
- Something that integrates inputs and computation
- A collection of digital logic that can execute machine instructions

What is a computer system

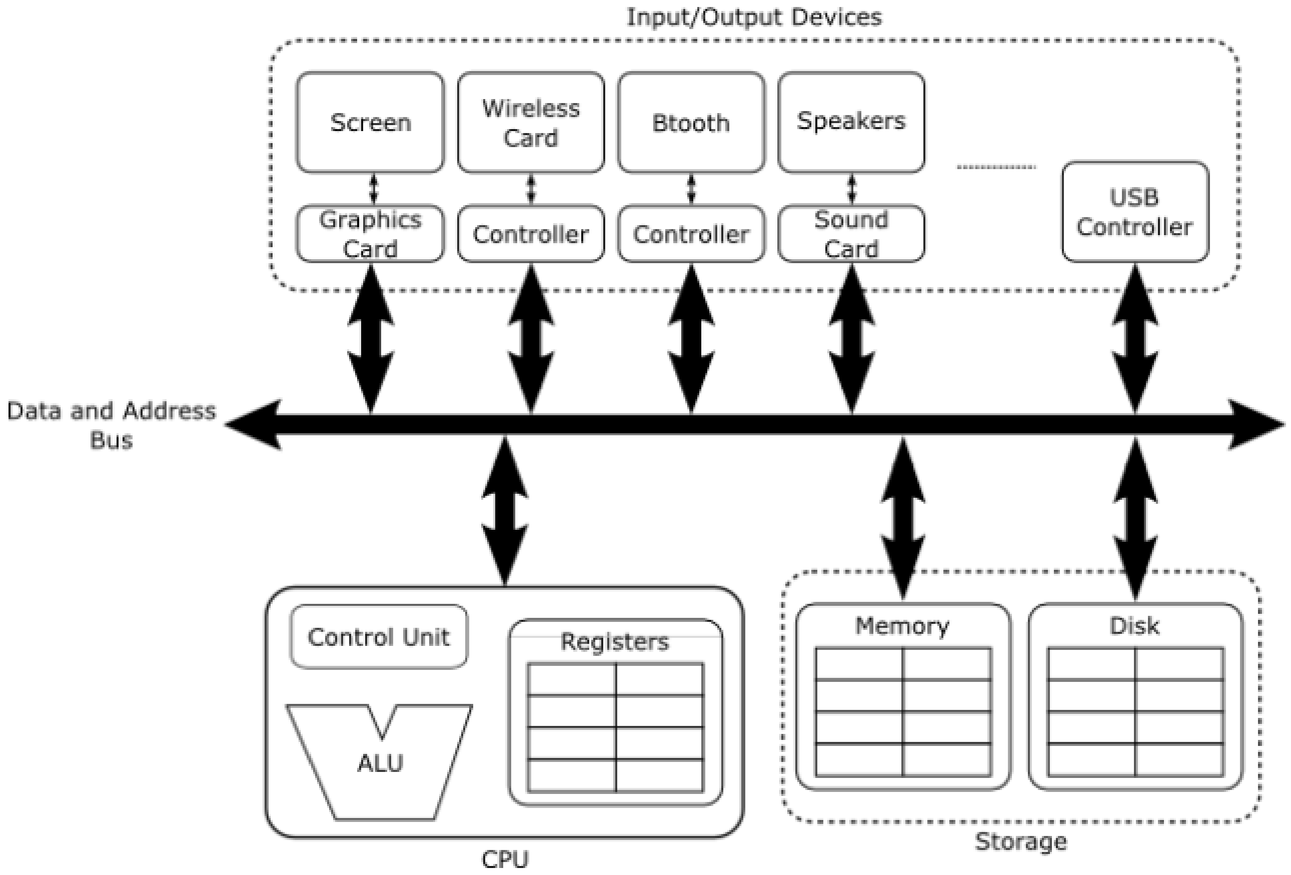
- Something you communicate through keyboard/mouse/touchscreen
- Supporter of apps
- Something that does mass arithmetic instructions
- Something that integrates inputs and computation
- A collection of digital logic that can execute machine instructions

- An electronic brain??

Exercise

- https://canvas.sydney.edu.au/courses/17907/pages/1-dot-6-1-micros-in-the-news

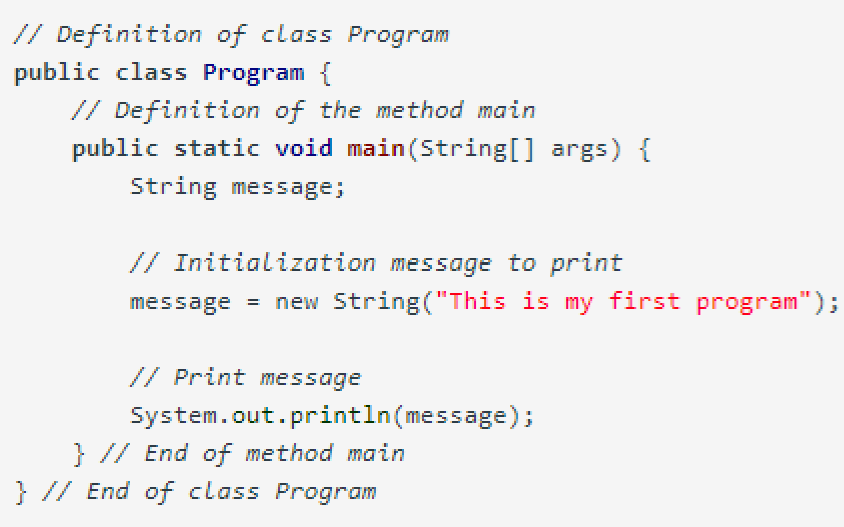
Structure of a computer system



Structure of a Computer System

What is a program

- Written in a programming language
- Meaning defined by language



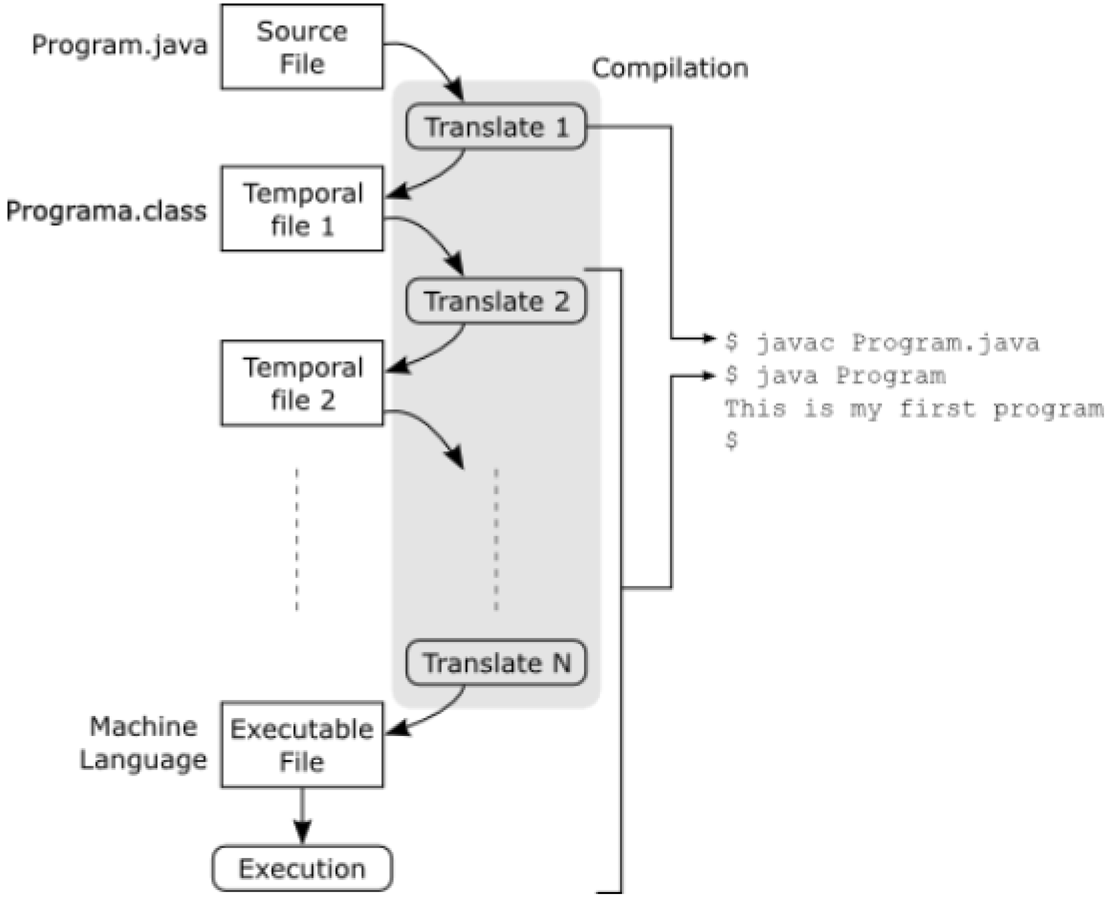
```java
// Definition of class Program
public class Program {
    // Definition of the method main
    public static void main(String[] args) {
        String message;

        // Initialization message to print
        message = new String("This is my first program");

        // Print message
        System.out.println(message);
    } // End of method main
} // End of class Program
```

Program to execution

- Sequence of steps

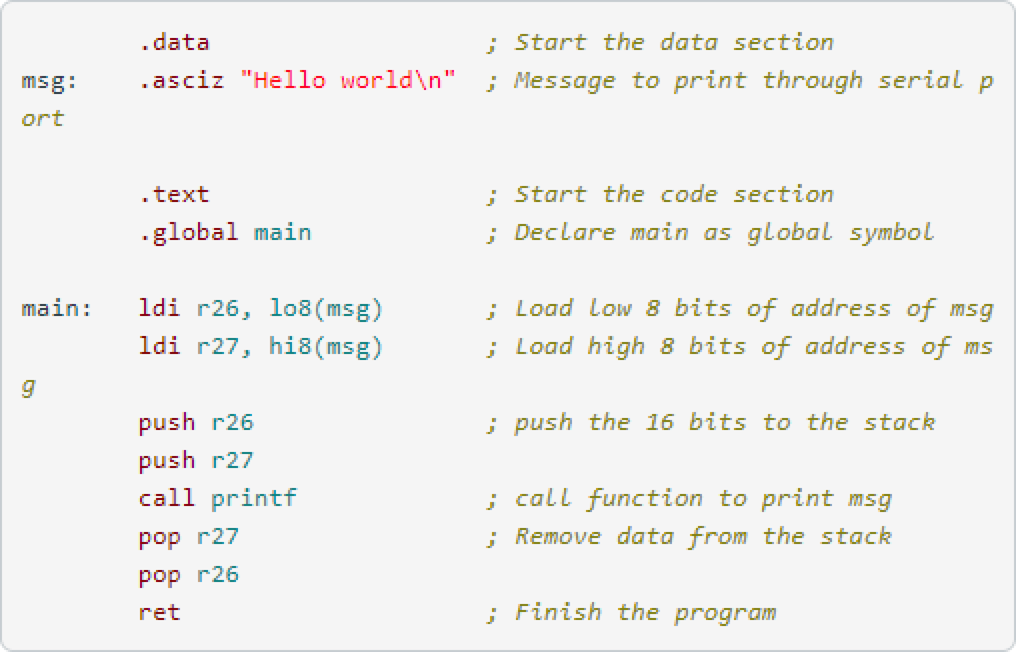


```
$ javac Program.java
$ java Program
This is my first program
$
```

Translation from a Java Program to an Executable

Assembly language

- Human readable machine language
- Map directly to binary digits



```
        .data                   ; Start the data section
msg:    .asciz "Hello world\n"  ; Message to print through serial p
ort

        .text                   ; Start the code section
        .global main            ; Declare main as global symbol

main:   ldi r26, lo8(msg)       ; Load low 8 bits of address of msg
        ldi r27, hi8(msg)       ; Load high 8 bits of address of ms
g
        push r26                ; push the 16 bits to the stack
        push r27
        call printf             ; call function to print msg
        pop r27                 ; Remove data from the stack
        pop r26
        ret                     ; Finish the program
```

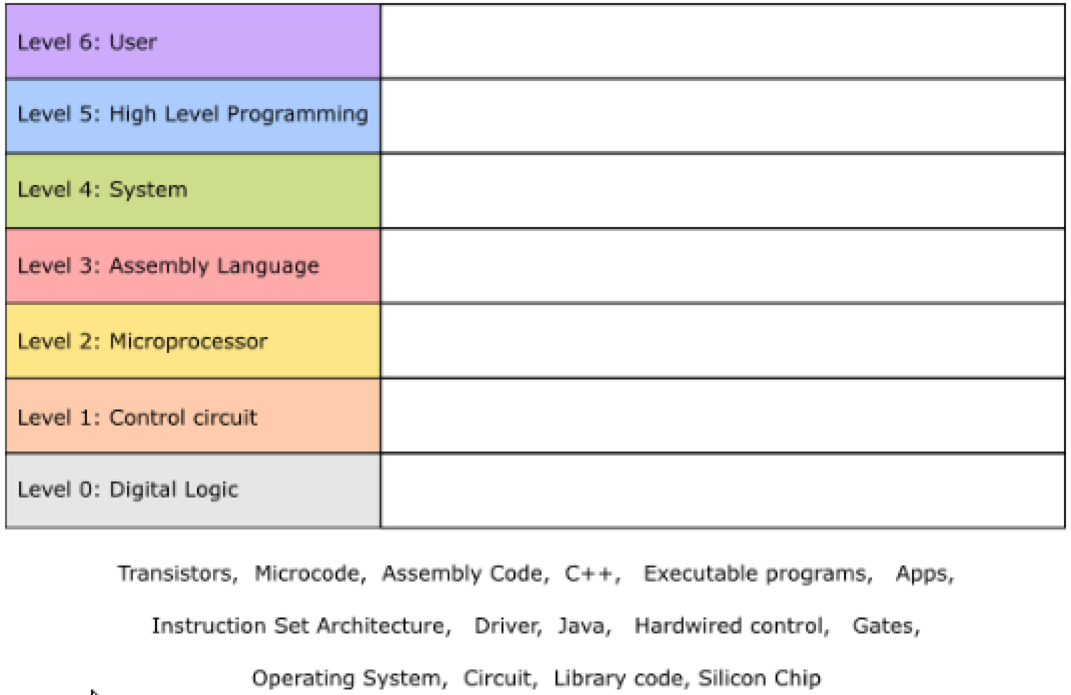
Can you program in assembly language?

- Yes…
- You can write extremely efficient code
  - But…You need to understand the processor in detail
  - You may not be smarter than a compiler…

Program execution

- Yes…
- You can write extremely efficient code
  - But…You need to understand the processor in detail
  - You may not be smarter than a compiler…

Abstraction



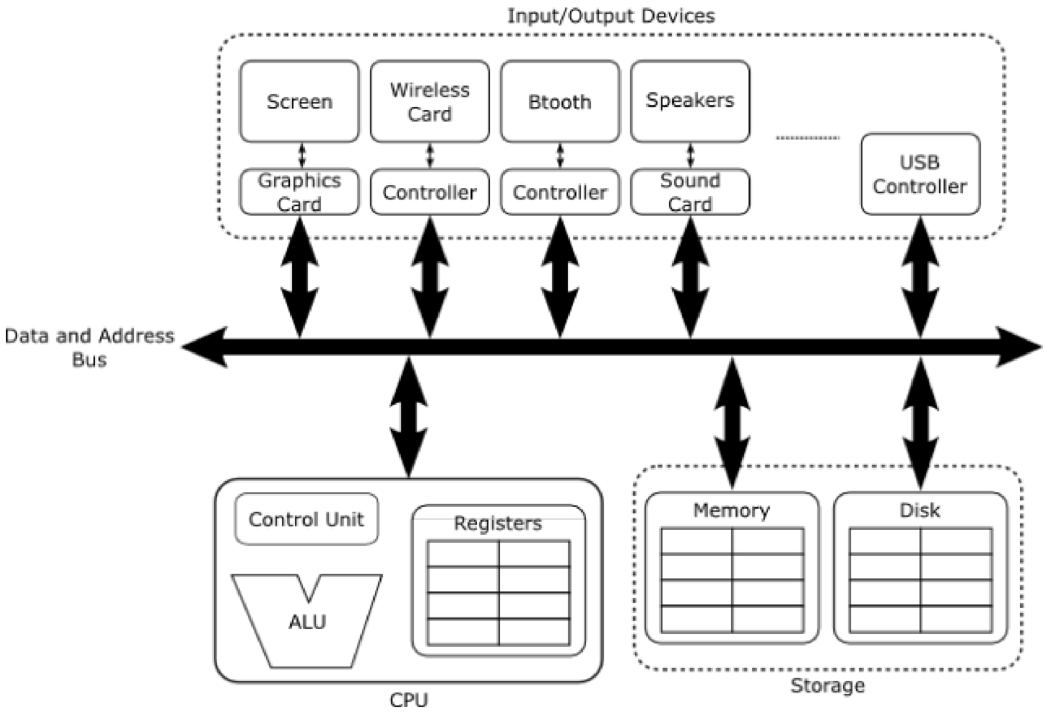
Level 6: User	
Level 5: High Level Programming	
Level 4: System	
Level 3: Assembly Language	
Level 2: Microprocessor	
Level 1: Control circuit	
Level 0: Digital Logic	

Transistors, Microcode, Assembly Code, C++, Executable programs, Apps,

Instruction Set Architecture, Driver, Java, Hardwired control, Gates,

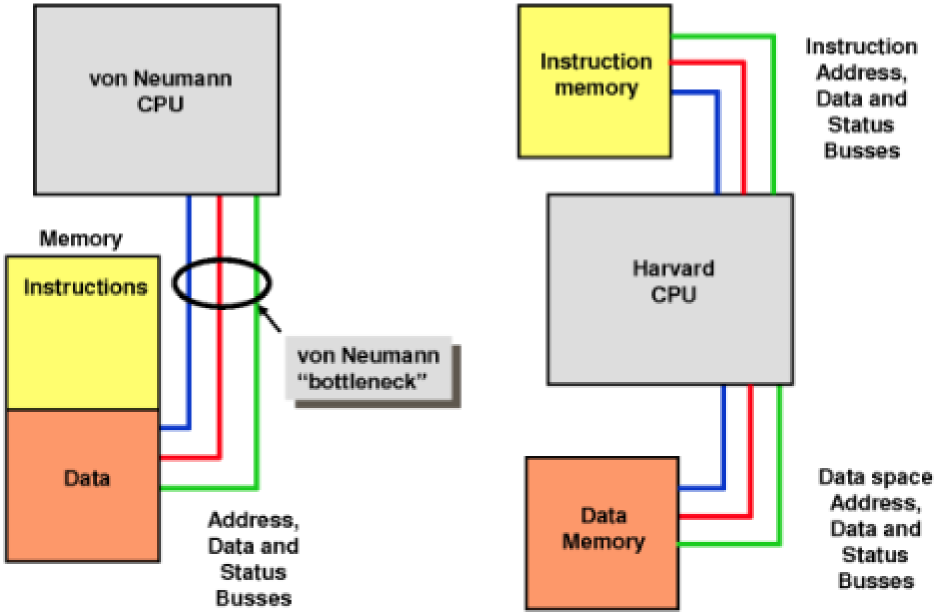
Operating System, Circuit, Library code, Silicon Chip

Are all computers the same?



Structure of a Computer System

von Neumann and Harvard Architectures


von Neumann CPU
Memory
Instructions
Data
von Neumann "bottleneck"
Address, Data and Status Busses
Instruction memory
Instruction Address, Data and Status Busses
Harvard CPU
Data Memory
Data space Address, Data and Status Busses

Hardware Computer Organization for the Software Professional
Arnold S. Berger