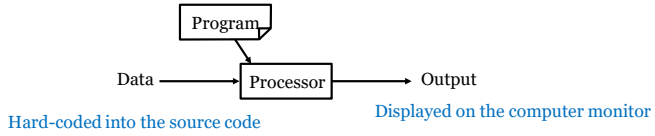
Outline

- In this presentation, we will:
  - Describe programs
  - Define programming languages
  - Look at our first program: *Hello world!*
  - Introduce:
    - Integrated development environments
    - On-line compilers
  - Describe the steps of compiling a program

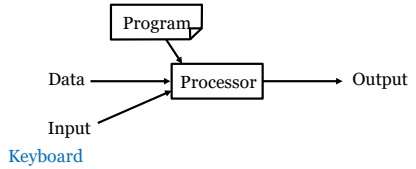
What is a program?

- To start, programs gives instructions to a processor to take data (numbers, text, or more generally, information) and perform some operations on (or *processes*) that data to solve a problem
- Initially, the result will be displayed on a screen



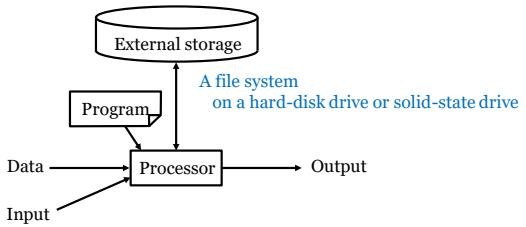
What is a program?

- By the end of this week,
  we will get data from a simple input device: the keyboard
- Definition: a *console* is the combination of a keyboard and screen



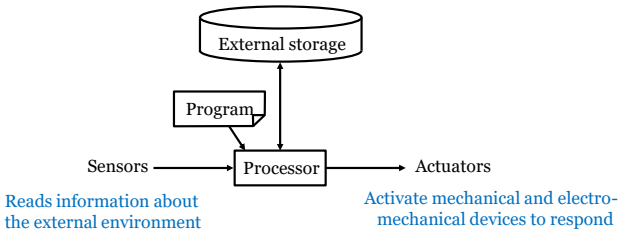
What is a program?

- By the middle of the course,
  we will access from and store data in files stored within a file system



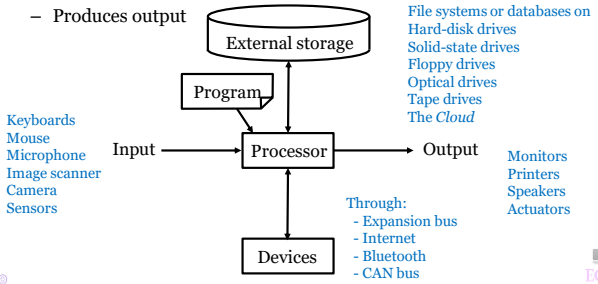
What is a program?

- In upper years,
  you will investigate embedded systems that are much simpler



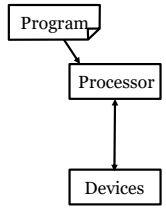
What is a program?

- In general, a program gives instructions to:
  - Receives input
  - Communicates with other devices
  - Reads and stores data in external storage
  - Produces output



What is a program?

- A simplified model:
  - A program provides instructions for the processor to communicate with devices to retrieve, process, store and send data



Why learn to program?

- Why learn programming?
  - Programming is a systematic means of giving instructions to perform a task
  - If you are in electrical engineering, we have authored a web site to try to help you understand why the material in this course is relevant:

    Why learn programming for electrical-engineering students?

    `https://ece.uwaterloo.ca/~ece150/Why_programming_for_EE/`

Executing programs

- When you execute/open/run/launch an application, your computer, laptop or smart phone begins executing *instructions*
  - These instructions are coded using a *binary encoding*:
    - 0 V or 5 V or `0`s and `1`s
  - The set of all possible instructions defines a *machine language*
  - These are difficult to read:

```
01100100 0011 0110 0101001000101010
01001110 0101 0011 0011100010001011
10001101 1010 0110 0000000000000000
```


Programming languages

- A *programming language* is a *human readable* means of specifying the operations a computer is to perform
- Programming languages are used to author *source code*
  - This source code is compiled and translated into machine instructions
  - The resulting instructions can then be executed
- Note that some programming languages are *interpreted*
  - Thus, C++ will be very different from Python or Maple or MATLAB
- Programming languages are restricted to the characters that appear on a standard keyboard
  - These are derived from ASCII
    - The American Standard Code for Information Interchange

Programming languages

- All of programming falls under the domain of mathematics
  - The Cheriton School of Computer Science is within the Faculty of Math
- We cannot use mathematical notation in programming languages, and thus we must use other means of describing our intentions

Expression	Representation in C++
$2(x+y)$	`2*(x + y)`
$\frac{n^3}{3}$	`(n*n*n)/3`
$\frac{1}{2}9.8s^2 + v_0 s$	`0.5*9.8*s*s + v0*s`
$\sin(x)$	`sin(x)`
$\lvert x \rvert$	`abs(x)`
$\sqrt{x}$	`sqrt(x)`

Our first program

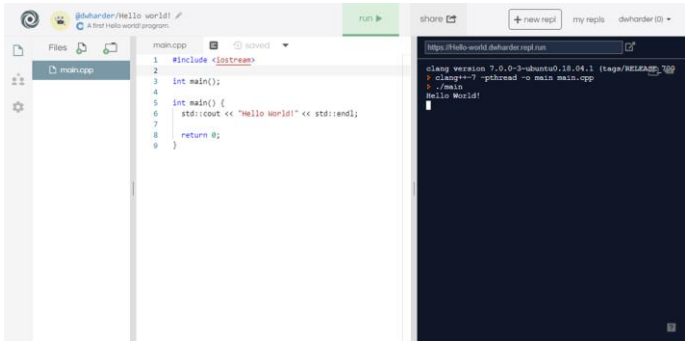
Comments allow for the programmer to add commentary in English – these are not part of the program

```
#include <iostream>

// Function declarations
int main();

// Function definitions
int main() {
    // Display this text to the console
    std::cout << "Hello world!" << std::endl;

    return 0;
}
```


Our first program

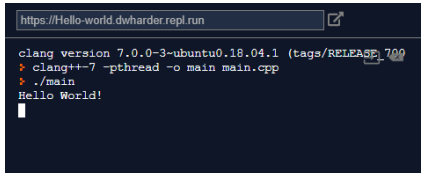
- There are three approaches we can take to authoring, compiling, executing and testing this code:
  - Using an Integrated Development Environment (IDE)
    - We will use Eclipse in the laboratories
  - Using an on-line compiler such as https://repl.it/
  - Using a text editor (`vi`) and a command-line compiler (`gcc`)
- On-line compilers, however:
  - May not always be available
  - Become increasingly useless for larger projects

Our first program



Our first program

- When you select the **Run** button, text is printed to the console output



  - Question: What is happening behind the scene?

Steps in generating an executable program

- The program undergoes the following four steps in order to create an executable program that you can run
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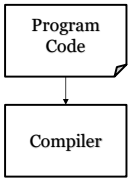

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  - Step 1: Creating the program using a programming language, and writing it using an editor
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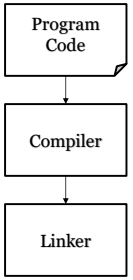
  - Step 3: Linking together the program with other helper programs into a single executable program
    - E.g., printing to the screen



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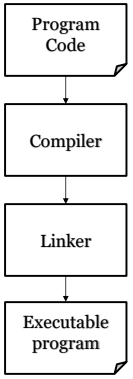
  - Step 4: Executing the program



Summary

- In this presentation, you now
  - Understand what a program is
  - Have an overview of how computers executing instructions
    - These are encoded in binary: `0`s and `1`s
  - Understand that programming languages allow us to define programs using a human-readable interface
    - The program must be compiled into an executable and run
  - Have written your first program: the ubiquitous *Hello world!*
  - Saw this output on https://repl.it
    - The first lab includes installing the Eclipse IDE
    - You are not required to use Eclipse, but it is the only IDE that is supported
  - Understand the steps of compilation

References

[1] https://en.wikipedia.org/wiki/APL_(programming_language)

Acknowledgments

Proof read by Dr. Thomas McConkey

Colophon

These slides were prepared using the Georgia typeface. Mathematical equations use Times New Roman, and source code is presented using `Consolas`.

The photographs of lilacs in bloom appearing on the title slide and accenting the top of each other slide were taken at the Royal Botanical Gardens on May 27, 2018 by Douglas Wilhelm Harder. Please see

https://www.rbg.ca/

for more information.



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