Software Lesson 1 Outline

What is Software? A Program? Data?

Software, for our purposes, is just a word that means "programs."

A ***program*** is a specific, precise, detailed description of:

- a collection of **data**

and

- a **sequence of actions** on those data.

The actions in a program are known as ***instructions***.

In computing, ***data*** are values stored in ***storage locations***:
for example, RAM, disk, etc.

What are Instructions?

The actions in a program are known as ***instructions***.

Examples:

- ***Arithmetic/Logical calculation***: for example, add, subtract, multiply, divide, square root, cosine, etc.
- ***Memory operations***: load from or store into RAM
- ***I/O***: read from or write to secondary storage
- ***Branch***: jump to an instruction that is out of sequence
- ***Repetition***
- ***Allocation*** of resources

… and many more.

What is a Programming Language?

A ***programming language*** is a **well-defined set of rules** for specifying a program's **collection of data** and **sequence of actions** on that data.

Examples: C, C++, Fortran 90, Python, Java, Basic, HTML, Perl, SAS, Haskell, Prolog, Pascal, Unix shell, x86 assembly language, etc.

https://en.wikipedia.org/wiki/List_of_programming_languages

There are said to be ~9000 programming languages so far:

https://hopl.info/

By comparison, there are said to be ~7000 natural languages in use today:

https://www.ethnologue.com/guides/how-many-languages

What is Source Code? What is a Source File?

Source code is a sequence of instructions,
written in a **human-readable** programming language,
that constitutes a program, or a piece of a program.

An example is shown on slide #8.

A ***source file*** is a file of source code.

What is an Operating System?

An ***operating system*** is a program that manages interactions between:

- users and hardware;
- users and software;
- hardware and software;
- hardware and hardware;
- software and software;

... and so much more.

Operating System Examples

- PC Operating Systems
  - Microsoft Windows
  - Apple MacOS – built on top of BSD (Unix)
- Phone and Tablet Operating Systems
  - Apple iOS (iPhone, iPad)
  - Android (many cell phones and tablets) – built on top of Linux
- Unix
  - Linux (portable)
  - FreeBSD (portable)
  - Solaris (Oracle)
  - AIX (IBM)
  - HP-UX (Hewlett-Packard)

  …

A Simple C Program

```
/*
 ************************************************
 *** Program: hello_world                     ***
 *** Author: Henry Neeman (hneeman@ou.edu)    ***
 *** Course: CS 1313 010 Spring 2024          ***
 *** Lab: Sec 014 Fridays 3:00pm              ***
 *** Description: Prints the sentence         ***
 ***   "Hello, world!" to standard output.    ***
 ************************************************
 */
#include <stdio.h>

int main ()
{ /* main */
    /*
     ********************************
     *** Execution Section (body) ***
     ********************************
     *
     * Print the sentence to standard output
     * (i.e., to the terminal screen).
     */
    printf("Hello, world!\n");
} /* main */
```

Anatomy of a Simple C Program

Comment (When they're big like this, we say "comment block.")

Preprocessor directive

Main function header

Block open

Execution section (also known as the ***program body***)

Block close

```
/*
*************************************************
*** Program: hello_world                      ***
*** Author: Henry Neeman (hneeman@ou.edu)     ***
*** Course: CS 1313 010 Spring 2024           ***
*** Lab: Sec 014 Fridays 3:00pm               ***
*** Description: Prints the sentence          ***
***   "Hello, world!" to standard output.     ***
*************************************************
*/
#include <stdio.h>

int main ()
{ /* main */
  /*
  ********************************
  *** Execution Section (body) ***
  ********************************
  *
  * Print the sentence to standard output
  * (i.e., to the terminal screen).
  */
  printf("Hello, world!\n");
} /* main */
```

Block Delimiters

The open curly brace, also known as the left brace,

{

acts as the start of a ***block*** and is known as the ***block open***.

The close curly brace, also known as the right brace,

}

acts as the end of a ***block*** and is known as the ***block close***.

The block open and block close are said to ***delimit*** the block: they indicate where the block begins and where the block ends.

Delimit: Indicate where something begins and ends.

What Is a Comment? #1

A ***comment*** is a piece of text in a source file that:

- **tells human beings** (for example, programmers) something useful about the program,

BUT

- is **ignored by the compiler**, so it has absolutely no affect on how the program runs.

In C, the start of a comment is indicated by

```
/*
```

and the end of a comment is indicated by

```
*/
```

All text appearing between these ***comment delimiters*** is part of the comment, and therefore is ignored by the compiler.

Delimit: Indicate where something begins and ends.

What Is a Comment? #2

A ***comment*** is a piece of text in a source file that:

- **tells human beings** (for example, programmers) something useful about the program,

BUT

- is **ignored by the compiler**, so it has absolutely no affect on how the program runs.

In C, the start of a comment is indicated by

```
/*
```

and the end of a comment is indicated by

```
*/
```

A comment **can use multiple lines** of text.

The delimiters **DON'T** have to be on the same line.

Are Comments Necessary?

Comments are ignored by the compiler, so strictly speaking they aren't needed to compile and run the program.

But, if you don't put them into one of your CS1313 programming projects, **YOU MAY LOSE A FULL LETTER GRADE OR MORE** on that project.

Why?

Comments tell human beings useful things about your program.

They help **programmers** – including you, a month later when you've forgotten everything about your program – to understand your program.

They also tell **graders** that you know what the heck you're doing.

hello_world.c with Comments

```
/*
 ************************************************
 *** Program: hello_world                     ***
 *** Author: Henry Neeman (hneeman@ou.edu)    ***
 *** Course: CS 1313 010 Spring 2024          ***
 *** Lab: Sec 014 Fridays 3:00pm              ***
 *** Description: Prints the sentence         ***
 ***   "Hello, world!" to standard output.    ***
 ************************************************
 */
#include <stdio.h>

int main ()
{ /* main */
    /*
     ********************************
     *** Execution Section (body) ***
     ********************************
     *
     * Print the sentence to standard output
     * (i.e., to the terminal screen).
     */
    printf("Hello, world!\n");
} /* main */
```

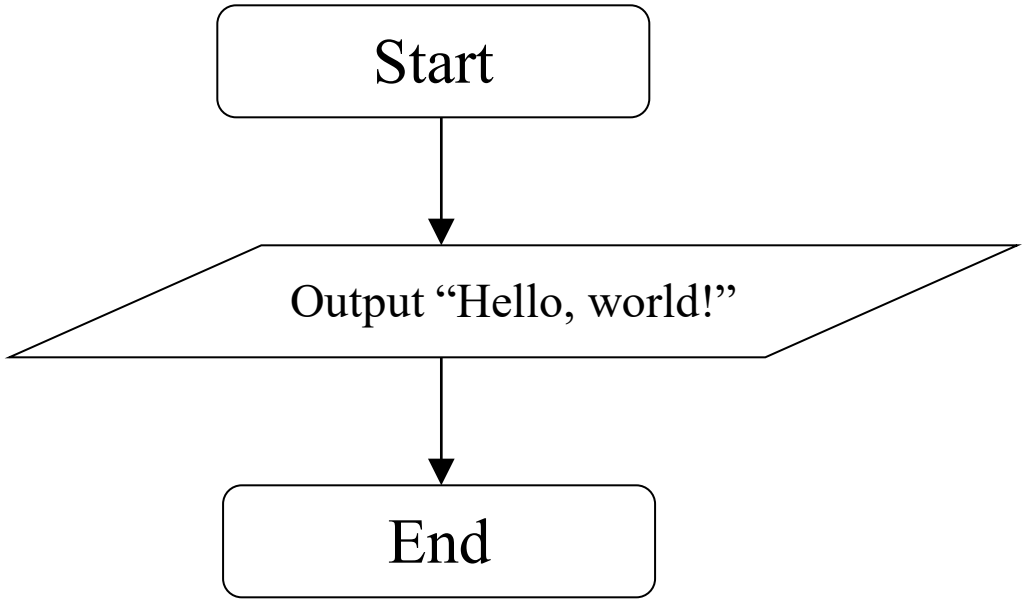
`hello_world.c` without Comments

```
#include <stdio.h>

int main ()
{
    printf("Hello, world!\n");
}
```

Flowchart for `hello_world.c`

```
int main ()
{
    printf("Hello, world!\n");
}
```



Reference:
http://www.edrawsoft.com/flowchart-symbols.php

An **oval** denotes either the start or the end of the program, or a halt operation within the program (which we'll learn about later).

A **parallelogram** denotes either an input operation or an output operation.

An **arrow** denotes the flow of the program.

Flowchart Example

https://live.staticflickr.com/5792/30767165600_2ff36d39c6_n.jpg

Outputting, Compiling and Running a C Program

```
% cat hello_world.c
/*
 ************************************************
 *** Program: hello_world                     ***
 *** Author: Henry Neeman (hneeman@ou.edu)    ***
 *** Course: CS 1313 010 Spring 2024          ***
 *** Lab: Sec 014 Fridays 3:00pm              ***
 *** Description: Prints the sentence         ***
 ***   "Hello, world!" to standard output.    ***
 ************************************************
 */
#include <stdio.h>

int main ()
{ /* main */
    /*
     ********************************
     *** Execution Section (body) ***
     ********************************
     *
     * Print the sentence to standard output
     * (i.e., to the terminal screen).
     */
    printf("Hello, world!\n");
} /* main */
% gcc -o hello_world hello_world.c
% hello_world
Hello, world!
```

Anatomy of Outputting, Compiling and Running

Unix prompt → `% cat hello_world.c` ← *Unix command to output to the screen*

```
/*
 ************************************************
 *** Program: hello_world                     ***
 *** Author: Henry Neeman (hneeman@ou.edu)    ***
 *** Course: CS 1313 010 Spring 2024          ***
 *** Lab: Sec 014 Fridays 3:00pm              ***
 *** Description: Prints the sentence         ***
 ***   "Hello, world!" to standard output.    ***
 ************************************************
 */
#include <stdio.h>

int main ()
{ /* main */
    /*
     ********************************
     *** Execution Section (body) ***
     ********************************
     *
     * Print the sentence to standard output
     * (i.e., to the terminal screen).
     */
    printf("Hello, world!\n");
} /* main */
% gcc -o hello_world hello_world.c
% hello_world
Hello, world!
```

Unix command to compile

Unix command to run

Program output

A Less Simple C Program #1

```
/*
 ************************************************
 *** Program: my_add                          ***
 *** Author: Henry Neeman (hneeman@ou.edu)    ***
 *** Course: CS 1313 010 Spring 2024          ***
 *** Lab: Sec 014 Fridays 3:00pm              ***
 *** Description: Input two integers, compute ***
 *** their sum and output the result.         ***
 ************************************************
 */
#include <stdio.h>

int main ()
{ /* main */
   /*
    ***************************
    *** Declaration Section ***
    ***************************
    *
    ****************************
    * Named Constant Subsection *
    ****************************
    */
    const int program_success_code =  0;
   /*
    *****************************
    * Local Variable Subsection *
    *****************************
    *
    * addend: The addend value that the user inputs.
    * augend: The augend value that the user inputs.
    * sum:    The sum of the addend and the augend,
    *   which is output.
    */
    int addend, augend, sum;
```

Continued on the next slide.

A Less Simple C Program #2

```
/*
 *************************
 *** Execution Section ***
 *************************
 *
 ************************
 * Greeting Subsection *
 ************************
 *
 * Tell the user what the program does.
 */
 printf("I'll add a pair of integers.\n");
/*
 ********************
 * Input subsection *
 ********************
 *
 * Prompt the user to input the addend & augend.
 */
 printf("What two integers do you want to add?\n");
/*
 * Input the integers to be added.
 */
 scanf("%d %d", &addend, &augend);
```

Continued on the next slide.

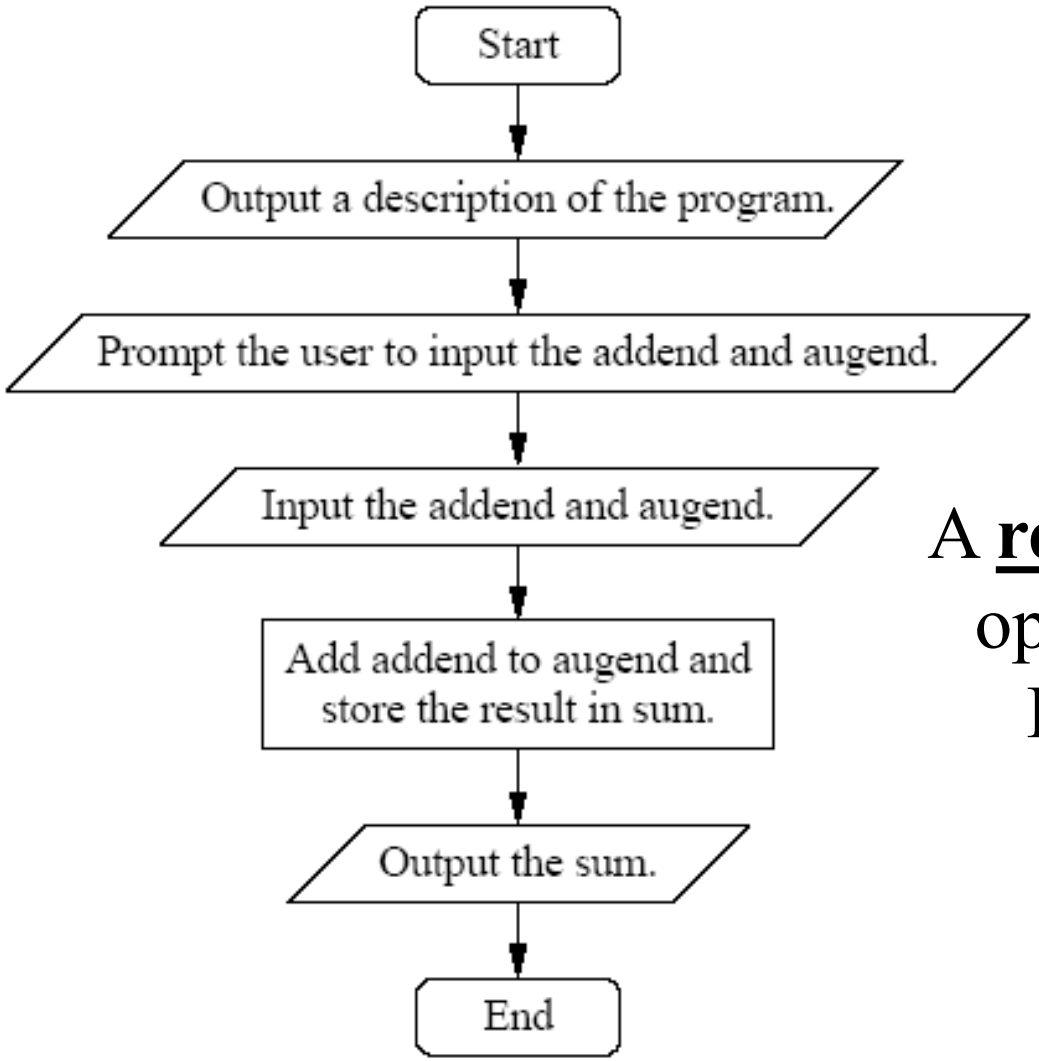
A Less Simple C Program #3

```
    /*
     *************************
     * Calculation Subsection *
     *************************
     *
     * Calculate the sum.
     */
     sum = addend + augend;
    /*
     *********************
     * Output Subsection *
     *********************
     *
     * Output the sum.
     */
     printf("The sum of %d and %d is %d.\n",
         addend, augend, sum);
     return program_success_code;
} /* main */
```

A Less Simple C Program: Compile & Run

```
% gcc -o my_add my_add.c
% my_add
I'll add a pair of integers.
What two integers do you want to add?
5 7
The sum of 5 and 7 is 12.
% my_add
I'll add a pair of integers.
What two integers do you want to add?
1593
09832
The sum of 1593 and 9832 is 11425.
```

Flowchart for `my_add.c`



A **rectangle** denotes an operation other than I/O or branching (for example, calculation).

Why Study C? #1

- Many other programming languages, including some of the most popular today, are based on C, so learning C prepares you to learn many other programming languages:
  "Many later languages have borrowed directly or indirectly from C, including C++, C#, Unix's C shell, D, Go, Java, JavaScript … , Julia, Limbo, LPC, Objective-C, Perl, PHP, Python, Ruby, Rust, Swift, Verilog and SystemVerilog ….[5] These languages have drawn many of their control structures and other basic features from C. Most of them … also express highly similar syntax to C, and they tend to combine the recognizable expression and statement syntax of C with underlying type systems, data models, and semantics that can be radically different."
  https://en.wikipedia.org/wiki/C_(programming_language)

Why Study C? #2

- C itself is the oldest programming language to have remained in the top 10 most popular programming languages for 50 years (so far) without interruption (including that C was the #1 most popular 1986-2001): https://www.youtube.com/watch?v=qQXXI5QFUfw
- These days, all of the top 10 programming languages are languages that are based on C (plus C itself).
- C is a ***procedural*** programming language, which helps you to appreciate the power and usefulness of ***object-oriented*** and ***functional*** programming languages if you learn them later.
- C is ***close to the metal***: How you program in C is a lot like how the hardware operates, so learning C helps you understand how computer hardware behaves.

Programming Exercise

- Write a program that outputs the following text:

I love programming!