Taming your first program

Due this week

- **Recitation**
  - Install VS Code
  - Tutorials and videos on Canvas, based on the operating system of your computer
- **Syllabus Quiz** due tonight!
- **Homework 0**
  - Submit zip file on Canvas.

- Check the due date!

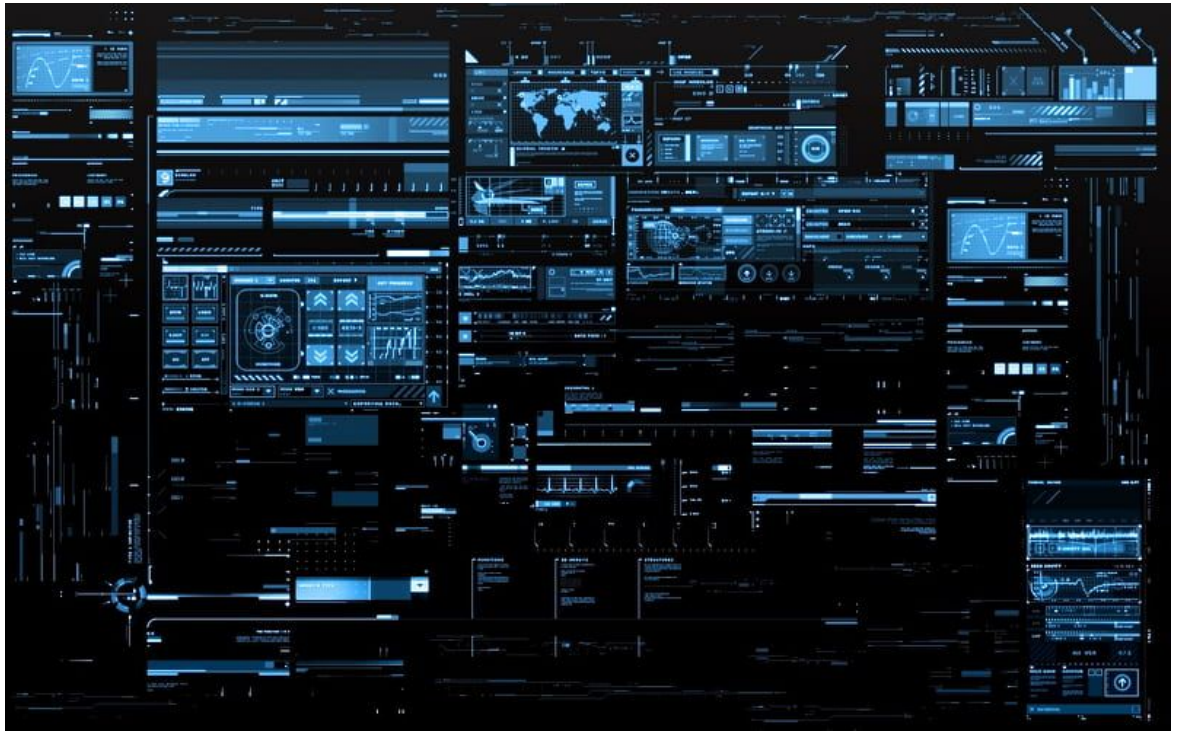
Before we dive in….

Let’s revisit

- Terminal
- Files and Folders
- Visual Studio Code (IDE)

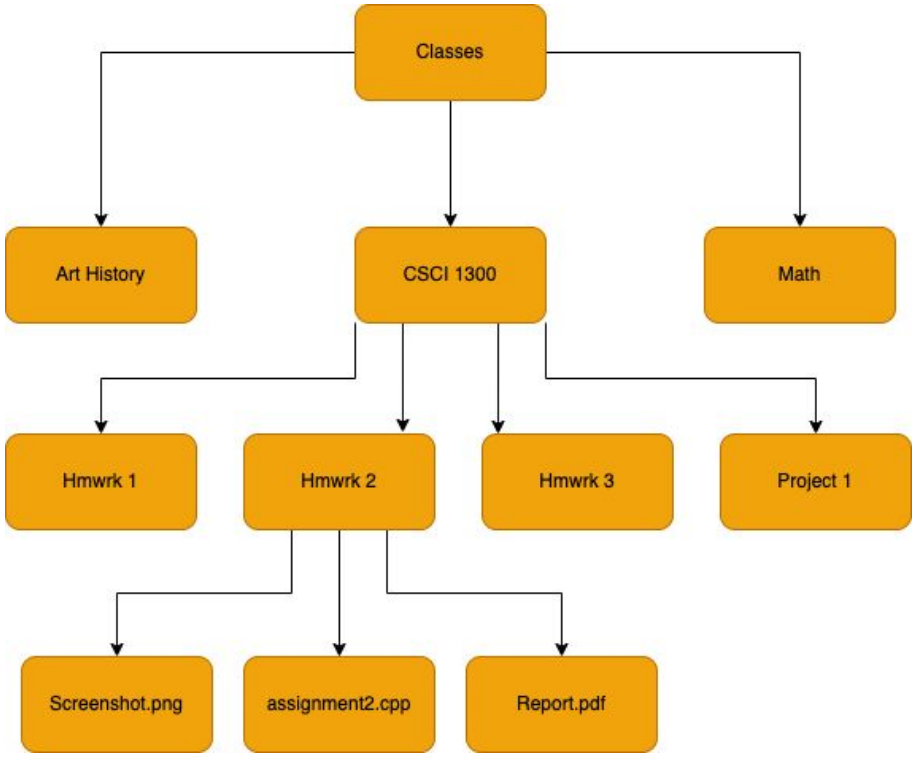
Terminal

- A text based interface to provide instructions to your computer
- You can do a lot of things using this - create files, folders, execute programs, or even surf the web!

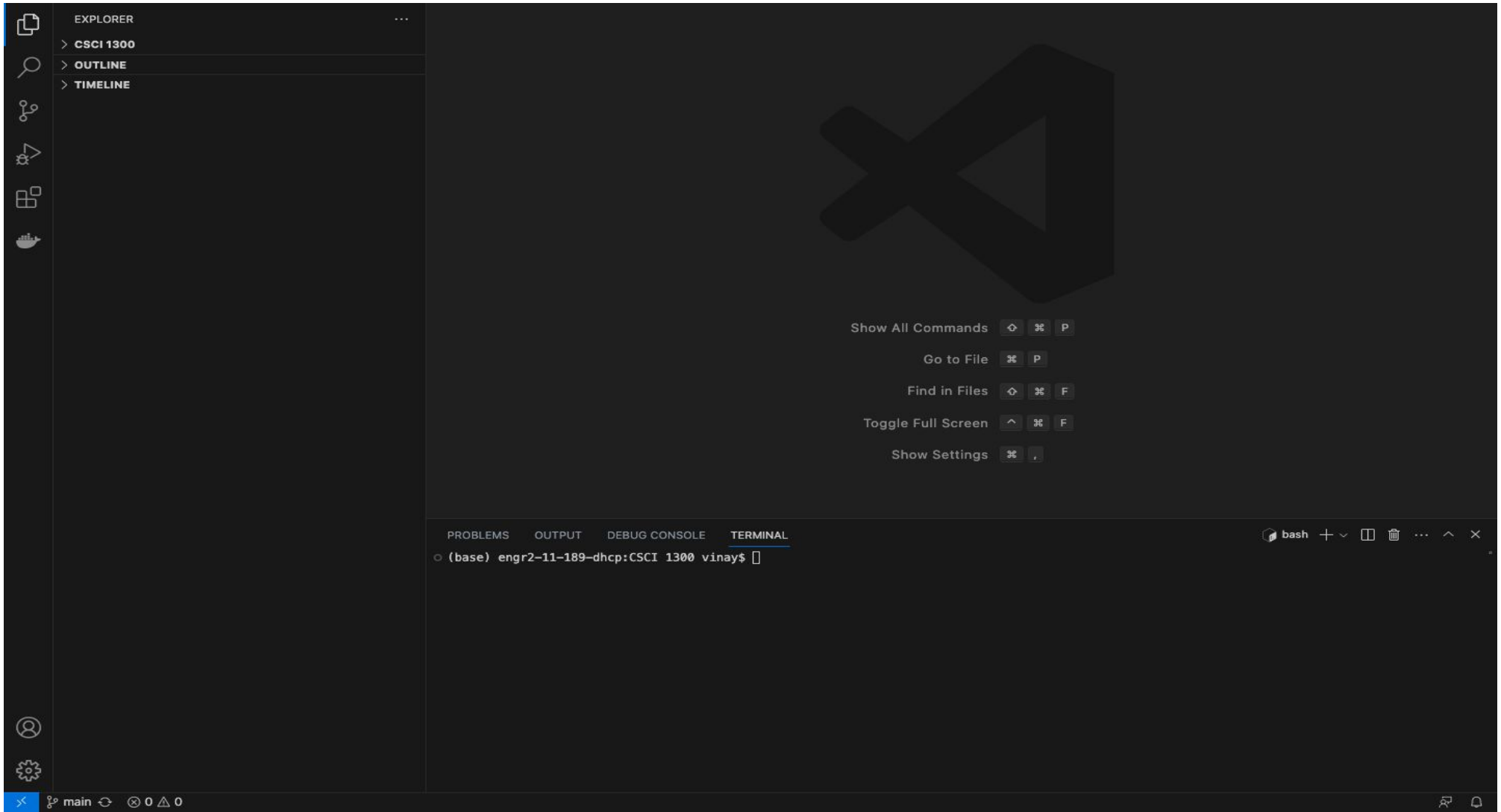


Files and Folders

- Keep the files and folders organized. Don’t clutter with unnecessary files
- Saves time, and eases managing large numbers of files



Visual Studio Code



Algorithms

Algorithms

- Every program is based on an algorithm (or more)
- An algorithm is like a recipe for cooking
  - It tells the ingredients (*inputs*)
  - It tells the sequential steps for processing the inputs
  - It tells the serving size and style (*outputs*)
- The computer acts like the cook, exactly following the algorithm recipe
- When your algorithm has enough detail (it clearly informs how you will write your code), you are usually writing in *pseudo code*

Recipe

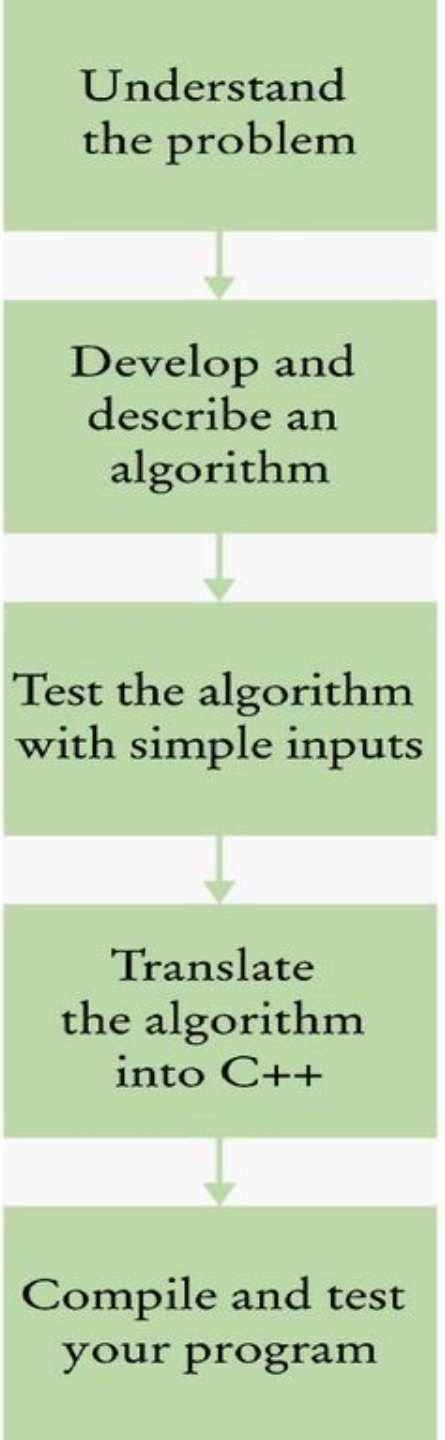
Pseudo Code

A notation resembling a simplified programming language for describing algorithms

- Intended for human readability, not a computer's
- Does not need to be syntactically correct code
- Provides a language independent way to describe the steps of an algorithm

The Software Development Process

- For each problem the programmer goes through these steps
- ***You MUST write an algorithm in words, pictures, and/or equations before attempting to translate to C++***



Variables

6 Building Blocks for Computational Representations

1. Create a variable to store a value for later use
2. Modify the value of a variable
3. Get input or generate output
4. Check if a statement is True or False
5. Repeat a statement or collection of statements
6. *Encapsulating a collection of statements*

6 Building Blocks for Computational Representations

1. Create a variable to store a value for later use

What is a variable?

- Have you encountered variables before? Where?

Variables	Values or quantities that change over time
Range of a variable	What are all the possible values it could take?
Variable type	Numeric, text, other

Example story: Alexis is 18 y.o. and her grandma is approaching 80.

Inspired by the VELA project: http://csforall.sri.com/

6 Building Blocks for Computational Representations

1. Create a variable to store a value for later use

Examples:

```
lemons = 5

oranges = 4

fruit = lemons + oranges
```

```
celsius = 15
```

6 Building Blocks for Computational Representations

2. Modify the value of a variable

Examples:

```
lemons = 5

oranges = 4

fruit = lemons + oranges

fruit = fruit + bananas
```

```
celsius = 15

fahrenheit  = celsius * 9 / 5 + 32
```

6 Building Blocks for Computational Representations

3. Get input or generate output

Examples:

lemons = 5

oranges = 4

fruit = lemons + oranges

fruit = fruit + bananas

Print out the number of fruits

get the celsius value from user (and save the value entered by the user in variable *celsius)*

fahrenheit = *celsius* * 9 / 5 + 32

Print the fahrenheit value

Variables

A **variable:**

- is used to **store** information (the **value**/**contents** of the variable)
  - can contain one piece of information at a time.
- has an **identifier** (the name of the variable)

- The programmer picks a good name
  - A good name describes the contents of the variable or what the variable will be used for
  - has a **type** (more about this very soon)

Variables: Like a parking garage

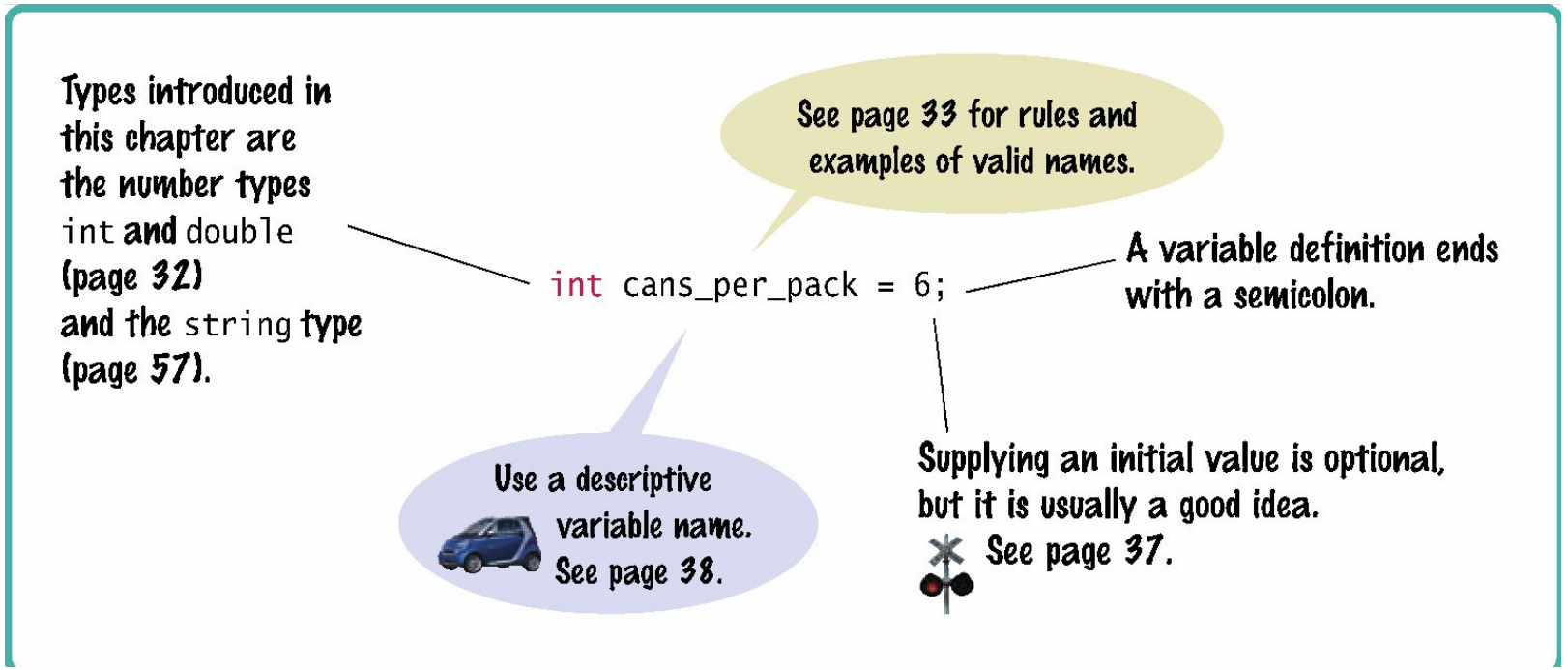
- Parking garages store cars.

- Each parking space is identified
  – like a variable's identifier
- Each parking space "contains" a car
  – like a variable's current contents
- Each space can contain only one car
- and not trucks or buses, just a car

Variable Definitions

- When creating variables, the programmer specifies the **type** of information to be stored.

- Unlike a parking space, a variable is often given an initial value.
  - ***Initialization*** is putting a value into a variable when the variable is created.
  - Initialization is **not required**.



Variable Definitions

Variable Definitions: example

The following statement defines a variable:

```
int cans_per_pack = 6;
```

`cans_per_pack` is the variable's name.

`int` indicates that the variable **cans_per_pack** will hold integers. Other variable types covered later will hold *strings* and *floating-point numbers*.

`= 6` indicates that the variable `cans_per_pack` will initially contain the value 6.

Like all statements, it must end with a semicolon.

The Assignment Statement

- The contents in variables can “vary” over time (hence the name!).
- Variables can be changed by
  - assigning to them
    - **The assignment statement** (”=“)
  - using the increment or decrement operator (++, --)
  - inputting into them
    - The input statement (“cin”)

Assignment Statement Example

- An *assignment statement* stores a new value in a variable, replacing the previously stored value.

```
cans_per_pack = 8;
```

- This assignment statement changes the value stored in **`cans_per_pack`** to be 8.

- The previous value is replaced.

The Meaning of the Assignment = Symbol

- The = in an assignment does ***not*** mean the left hand side is equal to the right hand side as it does in math.
- = is an instruction to do something:

  copy the value of the expression on the right
  into the variable on the left.

- Consider what it would mean, mathematically, to state:

```
counter = counter + 2;
```

counter *EQUALS* counter + 2

Assignment Statement: defining vs. assigning

- There is an important difference between a variable definition and an assignment statement:

```
int cans_per_pack = 6; // Variable definition
...
cans_per_pack = 8; // Assignment statement
```

- The first statement is the *definition* of **`cans_per_pack`**.
- The second statement is an *assignment statement.*
  - An *existing* variable's contents are replaced.
- A variable's definition must occur ***only once*** in a program. The same variable may be in several assignment statements in a program.

Assignment Examples

```
counter = 11; // set counter to 11
counter = counter + 2; // increment
```

1. First statement assigns 11 to counter
2. Second statement looks up what is currently in the variable counter (11)
3. Then it adds 2 and copies the result of the addition into the variable on the left, changing counter to 13

Variable Definitions: more examples

Table 1: Variable Definitions in C++

	Comment
int cans = 6;	Defines an integer variable and initializes it with 6.
int total = cans + bottles;	The initial value need not be a constant. (Of course, cans and bottles must have been previously defined.)
int bottles = "10";	Error: You cannot initialize an int variable with a string.
int bottles;	Defines an integer variable without initializing it. This can be a cause for errors—see Common Error 2.2.
int cans, bottles;	Defines two integer variables in a single statement. In this book, we will define each variable in a separate statement.
bottles = 1;	Caution: The type is missing. This statement is not a definition but an assignment of a new value to an existing variable—see Section 2.1.4.

Table 2: Number Literals

	Type	Comment
6	int	An integer has no fractional part.
–6	int	Integers can be negative.
0	int	Zero is an integer.
0.5	double	A number with a fractional part has type double.
1.0	double	An integer with a fractional part .0 has type double.
1E6	double	A number in exponential notation: 1 × 106 or 1000000. Numbers in exponential notation always have type double.
2.96E-2	double	Negative exponent: 2.96 × 10–2 = 2.96 / 100 = 0.0296
100,000		Error: Do not use a comma as a decimal separator.
3 1/2		Error: Do not use fractions; use decimal notation: 3.5.

Variable Name	Comment
can_volume1	Variable names consist of letters, numbers, and the underscore character.
x	In mathematics, you use short variable names such as x or y. This is legal in C++, but not very common, because it can make programs harder to understand (see Programming Tip 2.1)
Can_volume	Caution: Variable names are case sensitive. This variable name is different from can_volume.
6pack	Error: Variable names cannot start with a number.
can volume	Error: Variable names cannot contain spaces.
double	Error: You cannot use a reserved word as a variable name.
ltr/fl.oz	Error: You cannot use symbols such as . or /

Common Error: Using Undefined Variables

You must define a variable before you use it for the first time.

For example, the following sequence of statements would not be legal:

```
double can_volume = 12 * liter_per_ounce;
double liter_per_ounce = 0.0296;
```

Statements are compiled in top to bottom order.

When the compiler reaches the first statement, it does not know that **`liter_per_ounce`** will be defined in the next line, and it reports an error.

Common Error: Using Uninitialized Variables

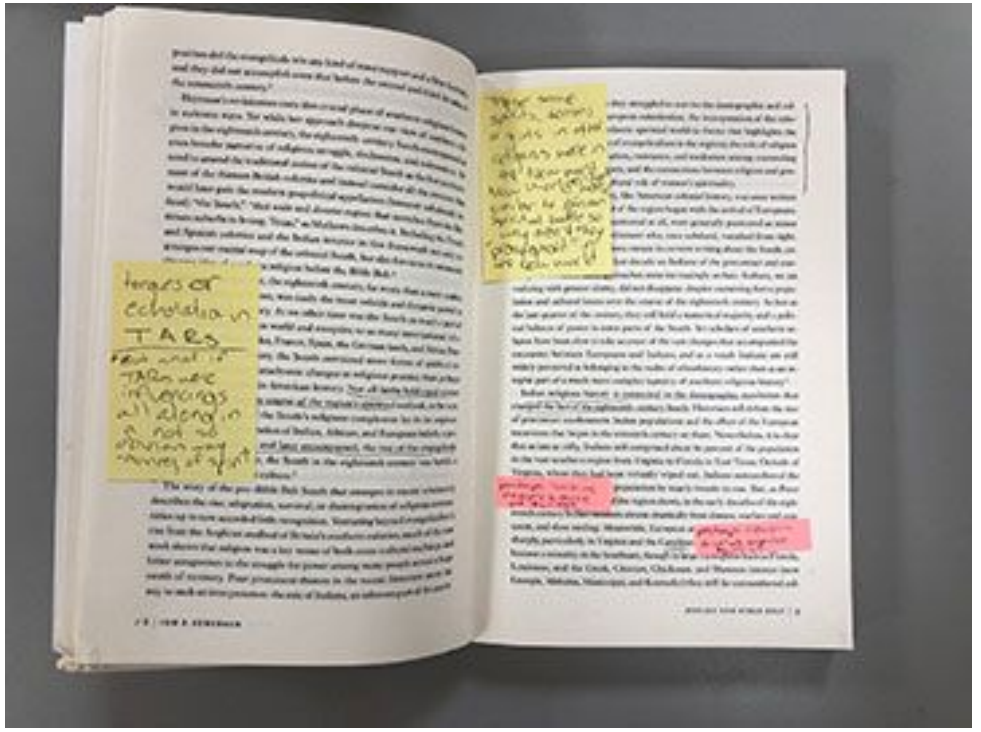
- Initializing a variable is not required, but there is always a value in every variable, even uninitialized ones.
- Some value will be there, left over from some previous calculation or simply the random value there when the transistors in RAM were first turned on.

```
int bottles; // Forgot to initialize
int bottle_volume = bottles * 2;
```

What value would be output from the following statement?

```
cout << bottle_volume << endl;
```

Comments



Is this you?

- Comments are explanations for human readers of your code (other programmers or your instructor).
- They are ignored by the compiler completely, it’s only for better readability and understanding

Comments: // or /* multi-line */

Comments can be written in two styles:

- Single line:

```
double can_volume = 0.355; // Liters in a 12-ounce can
```

The compiler ignores everything after **//** to the end of line

- Multiline for longer comments, where the compiler ignores everything between /* and */

```
/*
   This program computes the volume (in liters)
   of a six-pack of soda cans.
*/
```

Your first program!

Your first program

- The classic first program that everyone writes: Hello World!
  - (yes, everyone who is anyone started with this one)
- Its job is to write the words *Hello World!* on the screen.

```
#include <iostream>
using namespace std;
int main()
{
  cout << "Hello, World!" << endl;
  return 0;
}
```

the #include

- The first line tells the compiler to include a service for “stream input/output”. Later you will learn more about this but, for now, just know it is needed to write on the screen.

```
#include <iostream>

using namespace std;
int main()
{
	cout << "Hello, World!" << endl;
	return 0;
}
```

using namespace std

- The second line tells the compiler to use the “standard namespace”. This is used in conjunction with the `<iostream>` first line for controlling input and output.

```
#include <iostream>

using namespace std;
int main()
{
	cout << "Hello, World!" << endl;
	return 0;
}
```

int main()

- The next set of code *defines* a ***function,*** named **`main`.**
  - Every C++ program must contain its one `main` function.
  - All function names must be followed by parentheses. In `main`'s case, the parentheses are empty.
- Braces `{ }` must enclose all the code that belongs to `main`. The braces tell the compiler where to start reading the `main` code, and where to finish.

```
#include <iostream>

using namespace std;
int main()
{
	cout << "Hello, World!" << endl;
	return 0;
}
```

`cout` statement

- To show output on the screen, we use **`cout`.**
- What you want seen on the screen is “sent” to the **`cout`** entity using the **`<<`** operator (sometimes called the insertion operator): **`<< "Hello, World!"`**
- **The curious non-word `endl` means end-of-line, which tells the display to move the cursor down to the start of the next line.**

```
#include <iostream>

using namespace std;
int main()
{
	cout << "Hello, World!" << endl;
	return 0;
}
```

`return` statement

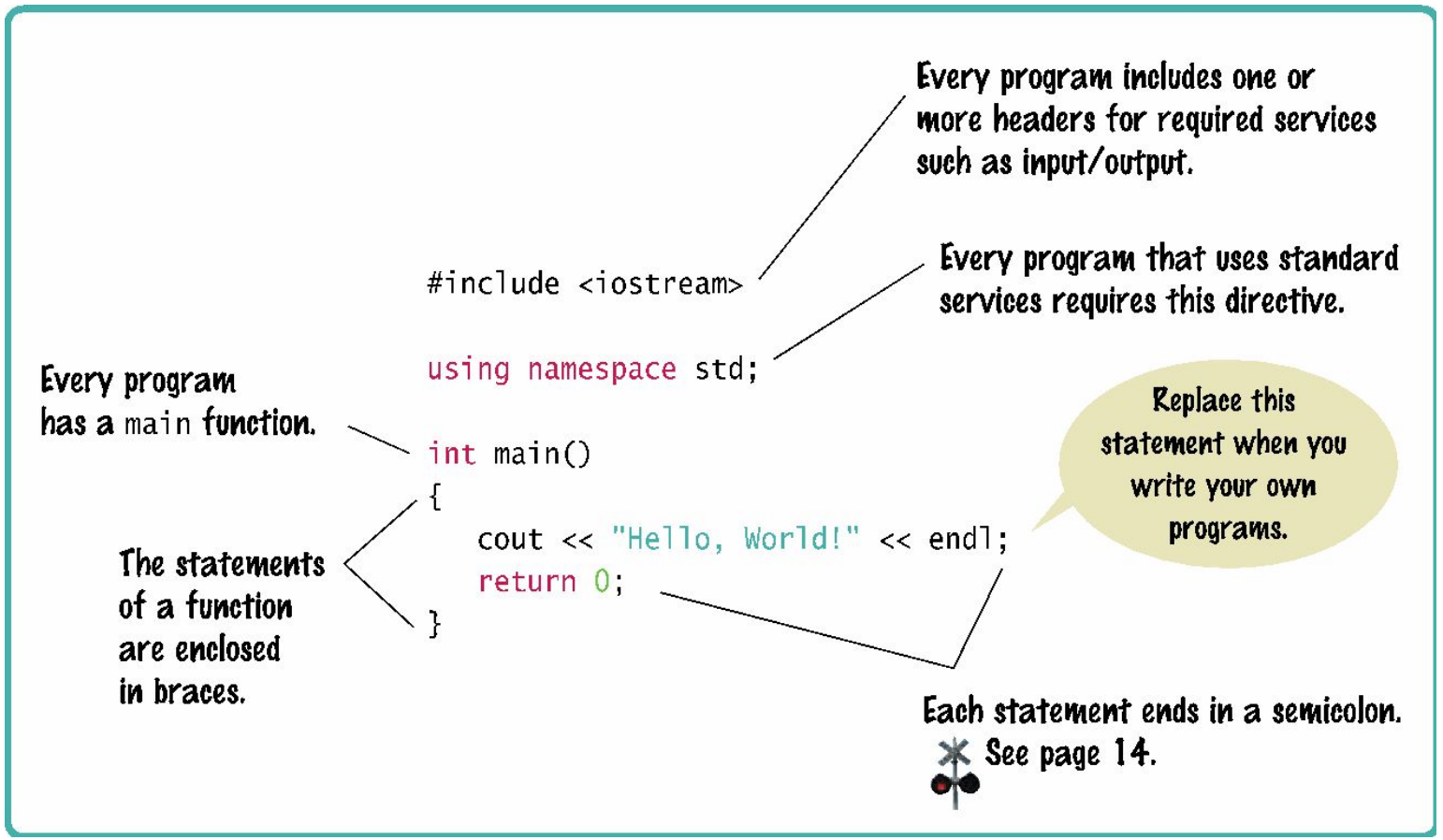
- The **`main`** function "returns" an "integer" (that is, a whole number without a fractional part, called **`int`** in C++) with value 0.
- This value indicates that the program finished successfully.

```
#include <iostream>

using namespace std;
int main()
{
	cout << "Hello, World!" << endl;
	return 0;
}
```

Semicolons are Required after Statements

- Each statement in C++ ends in a semicolon;
  - Note that not every line in a program is a statement, so there are no semicolons after the `<iostream>` line and the `main()` line
  - It is a strange idiosyncrasy, but you will get used to it

```
#include <iostream>

using namespace std;
int main()
{
      cout << "Hello, World!" << endl;
      return 0;
}
```



Errors!

Common Error – Omitting Semicolons errors

Omitting a semicolon (or two), in this case at the end of the `cout` statement

```
#include <iostream>

using namespace std;
int main()
{
	cout << "Hello, World!" << endl
	return 0;
}
```

Syntax errors

Without that semicolon you actually wrote:

```
cout << "Hello, World!" << endl return 0;
```

which thoroughly confuses the compiler with the `endl` immediately followed by the `return`!

- This is a *compile-time error* or *syntax error*.
- A syntax error is a part of a program that does not conform to the rules of the programming language.

Errors: Misspellings

- Suppose you (accidentally of course) wrote:

```
cot << "Hello World!" << endl;
```

- This will cause a compile-time error and the compiler will complain that it has no clue what you mean by cot.
- The exact wording of the error message is dependent on the compiler, but it might be something like

“Undefined symbol cot” or "Unknown identifier".

Compiler is a complaint box!

- The compiler will not stop compiling, and will most likely list lots and lots of errors that are caused by the first one it encountered.
- You should fix only those error messages that make sense to you, **starting with the first one**, and then recompile (after SAVING, of course!).

- *To Practice: Compiler commands and short-cuts on keyboard*

Logic Errors

Consider this:

```
cout << "Hollo, World!" << endl;
```

- *Logic errors* or *run-time errors* are errors in a program that compiles (the syntax is correct), but executes without performing the intended action.
- The programmer must thoroughly inspect and test the program to guard against logic errors.
  - *Testing and repairing a program usually takes more time than writing it in the first place, but is essential !*

Errors: Run-Time Exceptions

Some kinds of run-time errors are so severe that they generate an *exception*: a signal from the processor that aborts the program with an error message.

For example, if your program includes the statement

```
cout << 1 / 0;
```

Your program may terminate with a “divide by zero” exception.

Errors: extra or misspelled main() function

- Every C++ program must have one and only one **`main`** function.
- Most C++ programs contain other functions besides **`main`** (more about functions next week).

Errors: C++ is Case Sensitive

C++ is *case sensitive.* Typing:

```
int Main()
```

will compile but will not link.

A link-time error occurs here when the linker cannot find the **`main`** function – because you did not define a function named **`main`**. (**`Main`** is fine as a name but it is not the same as **`main`** and there has to be one **`main`** somewhere.)

If you want to learn more about the build process, read this. The content in this webpage is not a part of the syllabus and will not be on any course related assignments.

Making your Program Readable (by Humans)

C++ has *free-form layout*

```
int main(){cout<<"Hello, World!"<<endl;return 0;}
```

- *will* compile (but is practically impossible to read)

A good program is readable:

- code spaced across multiple lines, one statement per line
- follows indentation conventions

"Strings" and `endl`

```
cout << "Hello World!" << endl;
```

- **`"Hello World!"`** is called a *`string`*.
- You must put those double-quotes around strings.

- The **`endl`** symbol denotes an *end of line* marker which causes the cursor to move down to the next screen line.

I’m buggy

spot_errors.cpp > ...

```
1   /*
2   I am a program filled with errors, so fix me up...
3   */
4
5   # include<iostream>
6
7   using namespace std
8
9   int Main {
10      |
11      cout << "Dont look at me and find speling mistakes";
12
13      int celsius value = 25;
14      cout << celsius value << endl;
15      retun 0;
16  }
```

Next time

- Arithmetic
- Input statement

Questions?