Lecture 4: Taming Your First Program

* We're going to FLY along today, so watching the video / checking out the annotated slides & examples is recommended.

Announcements and reminders

Submissions:

- HW 1 (picobot) -- due Wednesday 24 Jan at 6 PM
- HW 2 (pseudocode) -- due Saturday 27 Jan at 6 PM

Course reading to stay on track:

- 1.7-2.3 for today
- 2.3-2.4 for Friday
- Ch. 5: Functions for next week (see calendar)

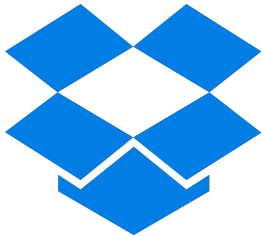
Back-up your work!

- GitHub (make it a **private** repository)
- Google Drive
- Dropbox

Don't care how. **No extensions** if you find that your assignment is lost to the ether the day before it is due.

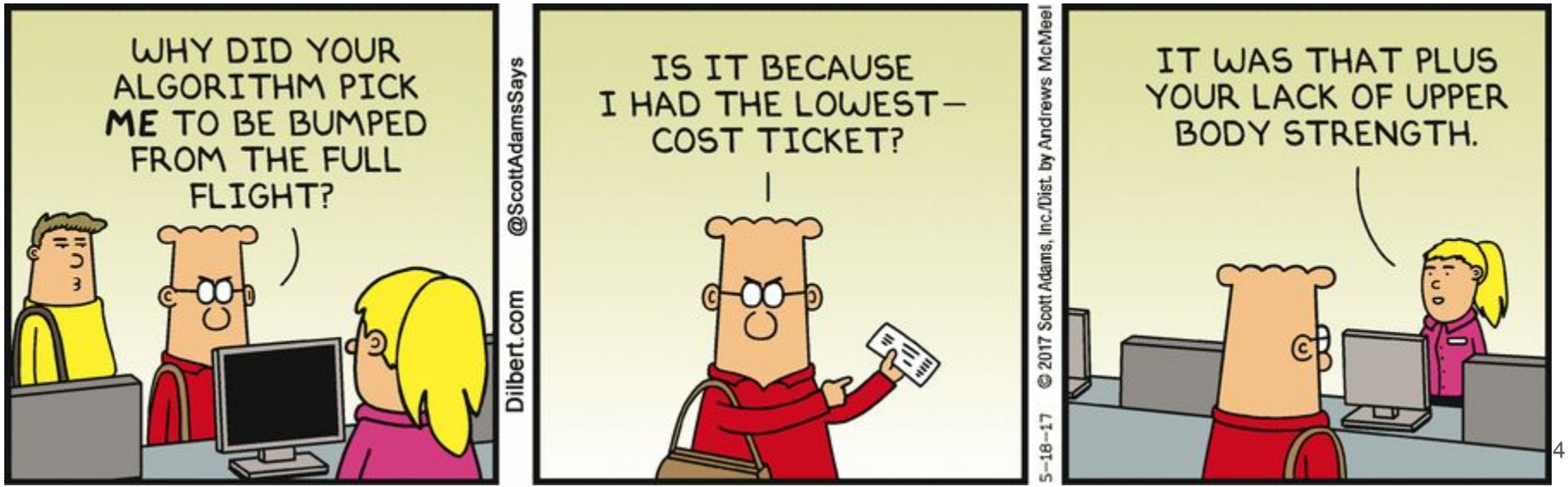
- You might want to revert to an earlier version
- Your computer might crash
- You might need to access your assignment from another computer

- **Use cloud storage - <u>always save your work in more than one place</u>!**



Last time on *Starting Computing…*

- We talked **pseudocode**
- We learned what the heck an **algorithm** is



Your first program

The classic first program everyone writes: Hello world!

Its job is to write the message “Hello world!” to the screen

Before we dive in, let’s all code it together!

You can code stuff however you want. Working in the Cloud9 IDE (integrated development environment)

1) https://ide.c9.io/
2) Sign into your Cloud9 account
3) Create a C++ workspace
   a) share w/ TA, and make sure it is **private**
4) Create folder for lecture # ___ or HW # ___
   For example: lec04_examples
   (to organize our work)

lec04
hw03

Your first program

helloworld.cpp

The classic first program everyone writes: Hello world!

Its job is to write the message “Hello world!” to the screen

It looks like this:

```
#include <iostream>
using namespace std;
int main()
{
      cout << “Hello world!” << endl;
      return 0;
}
```

Crystal clear right?
… Of course not. Let’s digest this a bit more.

Your first program

`#include <iostream>` -- tells compiler to include service for “stream input/output” (need for writing output to the screen)

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using namespace std; -- tells compiler to use the standard (“std”) namespace. Along with iostream, this lets us control input/output

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f(x)

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        return 0;
}
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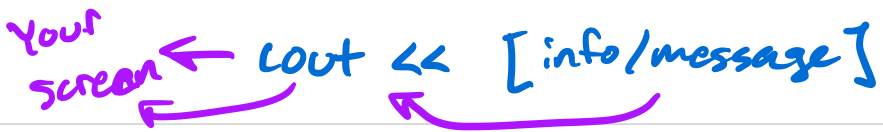
int main() -- this is a **function** called main

- Every C++ program must contain one main function
- All function names are followed by parentheses. In main’s case, these parentheses are empty
- Curly braces { } surround the code that belongs to main. These tell the compiler where to start reading the main code and where to end.

Your first program



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

take this message

display on this output

int main() -- this is a **function** called main

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cout statement -- shows output on the screen ("console output")

- What you want to print to screen ("Hello world!") is sent to cout entity using the << insertion operator
- endl tells the compiler "end-of-line"

Your first program

$f(x) = x^2$ $f(2) = 4$

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return statement -- returns as fcn output an integer with value 0. Indicates program finished successfully

cout statement -- shows output on the screen ("console output")

- What you want to print to screen ("Hello world!") is sent to cout entity using the << insertion operator
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Your first program

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

Other notes:

- Every program includes one or more headers for required services (e.g., input/output)
- Every program using standard services needs the namespace std directive
- **Every** program has a `main` function
- The statements of a function are **always** enclosed in braces (curly brackets { })
- This line is the “meat and cheese” of your program. To do other things, replace it with other codes!
- Every statement ends in a semicolon ; (So compiler knows where lines begin/end)

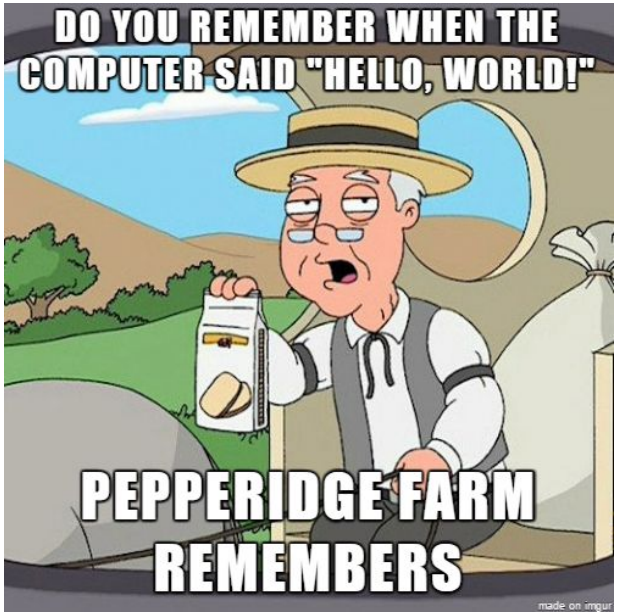
Output statements -- the streaming operator <<

The statement `cout << "Hello world!" << endl;` is an ***output statement***.

- To display values on the screen, you send them to an entity called `cout` (console/character output)
- The << operator is called the ***streaming operator*** and is the computery way of saying “send to”
  - Can send **strings** and **numbers** to `cout`

"Hello" = string (character) letters

5 = number



Output statements -- strings and endl

The statement `cout << "Hello world!" << endl;` is an ***output statement***.

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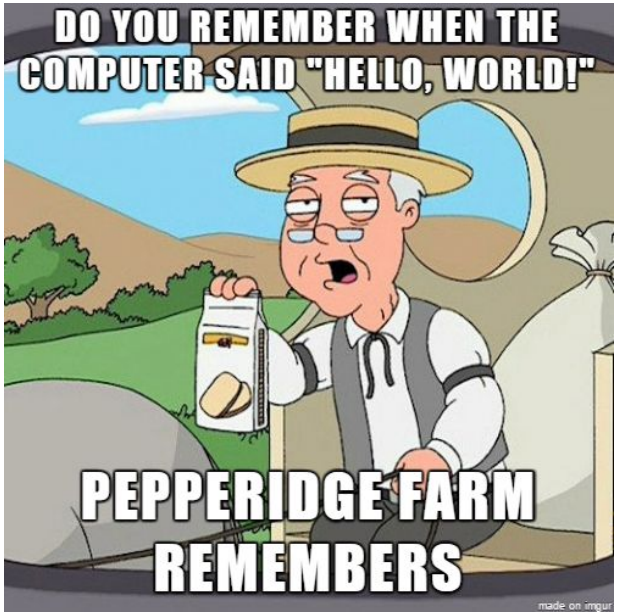
- The << operator is called the ***streaming operator*** and is the computery way of saying “send to”
  - Can send **strings** and **numbers** to `cout`
- `"Hello world!"` is called a ***string*** (or **character string**).
  - Double quotes are needed to denote a char string
- `endl` symbol denotes the end of the line
  - Moves cursor down to next line (line break in output)



Output statements -- printing multiple items

Can display more than one thing by chaining or *streaming* multiple copies of the << operator into the same statement.

Example: S'pose we want to print the message "Hello cruel science world!" to the screen, but only one word at a time.

```
#include <iostream>
using namespace std;
int main()
{
    
    return 0;
}
```

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Example: S'pose we want to print the message "Hello cruel science world!" to the screen, but only one word at a time.

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

Notice anything weird-looking?

Output statements -- printing multiple items

Can display more than one thing by chaining or *streaming* multiple copies of the << operator into the same statement.

Example: S'pose we want to print the message "A big number is [37*41]" to the screen, where [37*41] is replaced by us actually computing the product of 37 and 41.

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using namespace std;
int main()
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    return 0;
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```

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#include <iostream>
using namespace std;
int main()
{
    cout << "A big number is " << 37*41 << endl;
    return 0;
}
```

Semicolons -- tough in English, easier in Comp Sci

Each statement in C++ ends in a semicolon ;

Not every line in a program is a statement
(e.g., no semicolons after the <iostream> line and the main() line)

Kind of weird, but you'll get used to it. Your compiler will yell at you anyway if you're missing some.

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#include <iostream>
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    cout << "Hello world!" << endl;
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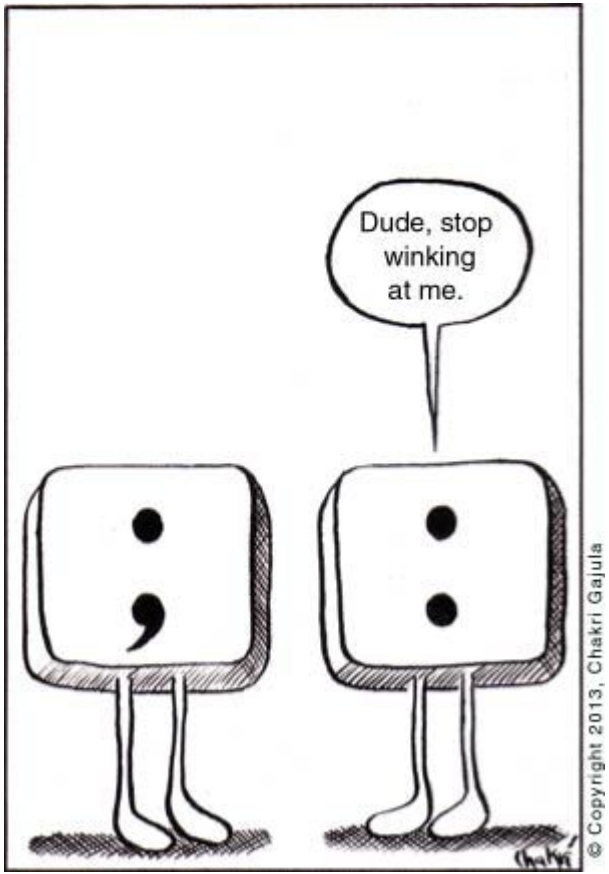

Common errors -- omitting semicolons

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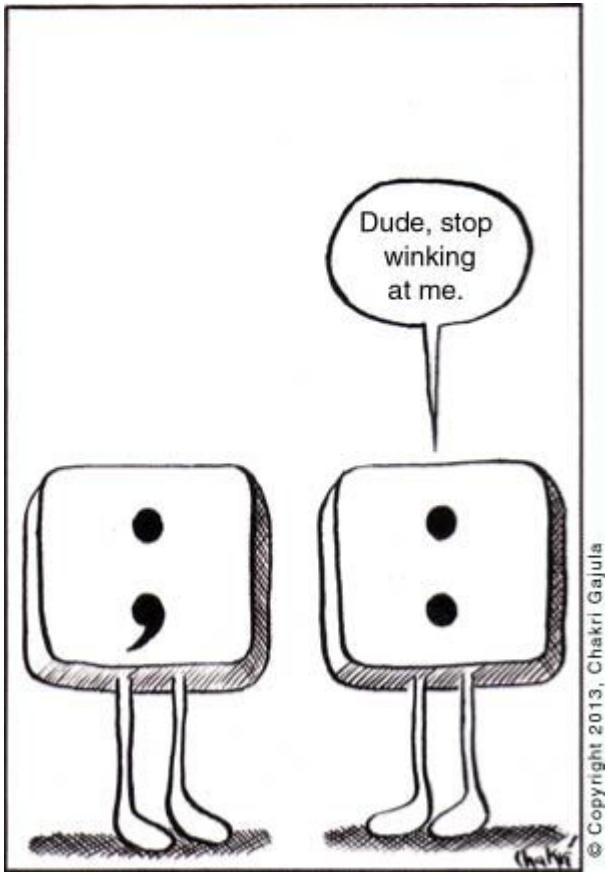
What happens if we screw this up??

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



Common errors -- omitting semicolons

Without the semicolon we actually wrote:

```
cout << "Hello world!" << endl return 0;
```

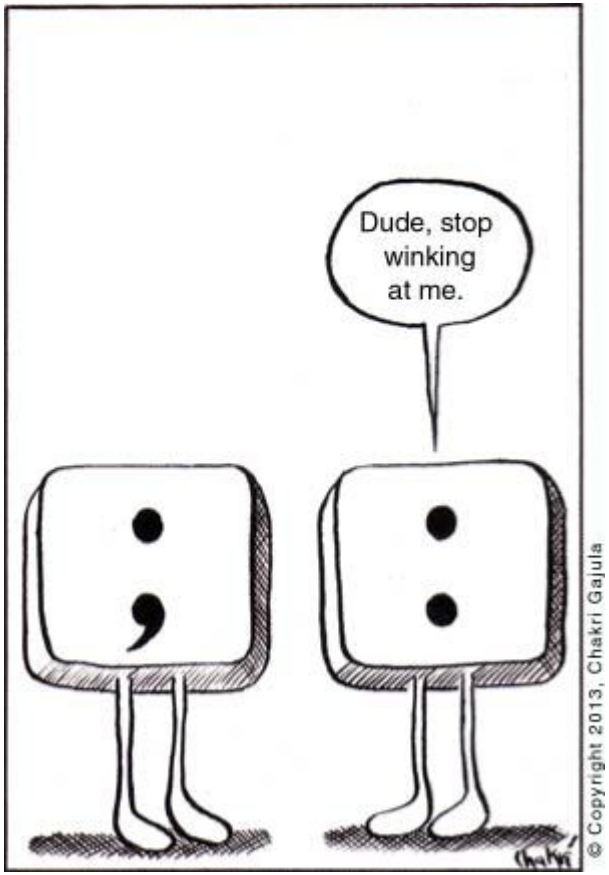
The "endl" immediately followed by "return" confuses the compiler

→ Gives an error:

```
helloworld.cpp:5:35: error: expected ';' after expression
    cout << "Hello world!" << endl
                                  ^
                                  ;
1 error generated.
```

→ This is a **compile-time/synatax error**

Definition: A **syntax error** is a part of a program that does not conform to the rules of the programming language.



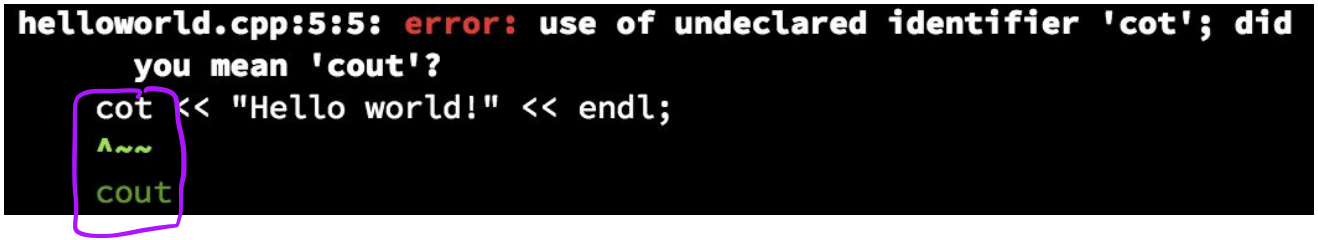
Common errors -- misspellings

S'pose you accidentally wrote:

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

The compiler will complain that it has no clue what you mean by "cot"

→ Gives a compile-time error:



The exact message and how helpful it is will depend on your compiler. (I used g++ here.)

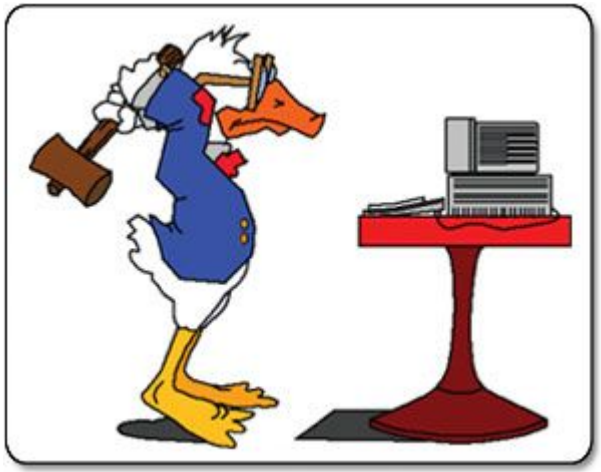
But it should say something like "Unknown identifier" or "Undefined symbol cot", or "'cot' was not declared"

Errors, errors, everywhere!

Compiler will not stop compiling, and probably will spit out lots and lots of errors that were caused by the first error.

Start debugging by **(1) starting from the beginning of the program** and
(2) starting with the most obvious/sensible errors.

SAVE your work after each fix, just in case fixing your code actually breaks it worse.



Logic errors

S’pose you accidentally wrote:

```
cout << "Hell world!" << endl;
```

Will compile and run just fine, but is probably not what you meant.

Definition: **Logic/run-time errors** are errors in a program that compiles (syntax is correct), but executes without performing the intended action.

Logic errors

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cout << "Hell world!" << endl;
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Will compile and run just fine, but is probably not what you meant.

Definition: **Logic/run-time errors** are errors in a program that compiles (syntax is correct), but executes without performing the intended action.

→ Your compiler will not protect you against logic errors!

→ The programmer must thoroughly inspect and test the code to guard against logic errors

→ Testing and debugging a program usually takes more time than writing it in the first place, but **it is essential**.

Errors: run-time exceptions

Definition: Some kinds of 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 contains the statement:

```
cout << "A crazy number is " << 1 / 0 << endl;
```

then your program will generate a divide-by-zero exception:

```
helloworld.cpp:7:39: warning: division by zero is undefined
      [-Wdivision-by-zero]
    cout << "A crazy number is " << 1 / 0 << endl;
                                       ^ ~
1 warning generated.
```

More errors

Extra or misspelled `main()` function

- Every C++ program must have exactly one `main` function
- Many C++ programs contain other functions besides `main` (more on this next week!)

More errors

Extra or misspelled main() function

- Every C++ program must have exactly one main function
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C++ is case-sensitive

`int Main()` will compile but it will not ***link***

Definition: A **link-time error** occurs 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 function with ***exactly*** the name "main" somewhere.)

Make your programs readable (by humans)

The program

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

spaces

will compile and run.

But it will make everyone hate you. Seriously. Just don't.

A good program is **readable by humans** too:

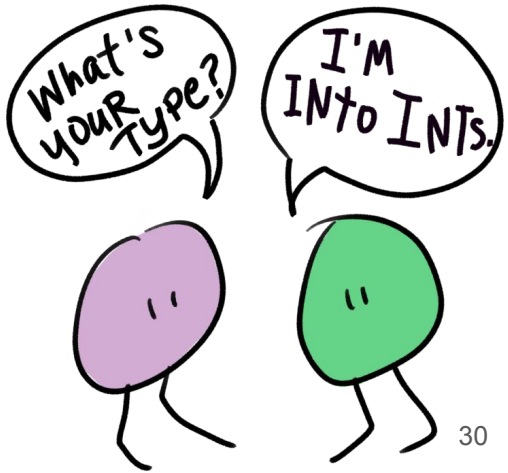
- ✓Code spread across multiple lines, with one statement per line
- ✓Follows indentation conventions (we'll see more later)
- Includes helpful **comments** (lines that begin with // or are surrounded by /* [stuff] */)

more later!

Chapter 2: Fundamental Data Types

Chapter goals:

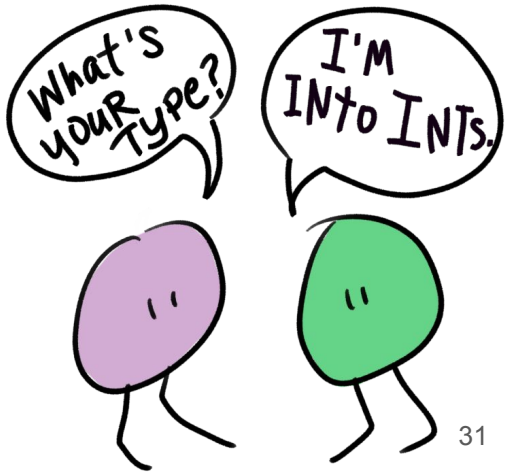
- To understand the properties and limitations of integer and floating-point numbers
- To write arithmetic expressions and assignment statements in C++
- To appreciate the importance of comments and good code layout
- To create programs that read and process input, and display the results
- To process strings, using the standard C++ string type



Chapter 2: Fundamental Data Types

Chapter topics:

- Variables ✓
- Arithmetic
- Input and output ✓
- Problem solving: first do it by hand
- Strings



Variables

- Used to **store information**
  - Contents contain one piece of information at a time
- Has a **name** (its identifier)
  - A good name describes the contents of the variable or what it will be used for

Variables

- Used to **store information**
  - Contents contain one piece of information at a time
- Has a **name** (its identifier)
  - A good name describes the contents of the variable or what it will be used for
- Is like a **parking garage**
  - Each parking space is identified *(like a variable's name)*
  - Each parking space contains a car *(like a variable's contents)*
  - Each parking space can contain only ***one*** car, and not trucks/buses, just cars

Variable definitions

- When creating a variable, you must **declare** the type of information the variable will hold
  - (more on this later)
- We often give variables an **initial value**
  - This **initialization** puts a value into a variable when the variable is created
  - Initialization is not required.

declare setting to 6

int cans_per_pack;

Example:

```
int cans_per_pack = 6;
```

Variable definitions

string name = "Tony";

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  - (more on this later)
- We often give variables an **initial value**
  - This **initialization** puts a value into a variable when the variable is created
  - Initialization is not required.

Example: `int cans_per_pack = 6;`

As always, end line with a semicolon ;

int = integer numbers
double = decimal numbers (or "floating point" values)
string = characters
(see Table 2 and Sec 2.5)

Use a **descriptive** variable name. "cpp" would be a crappy name. *(see Table 3 for variable naming rules)*

Supplying an initial value is option, but often a good idea. *(see Common Error 2.2)*

Variable definitions: more examples

Declaration	Comment
`int cans = 6;`	
`int total = cans + bottles;`	
`int bottles = "10";`	
`int bottles;`	
`int cans, bottles;`	
`bottles = 1;`	

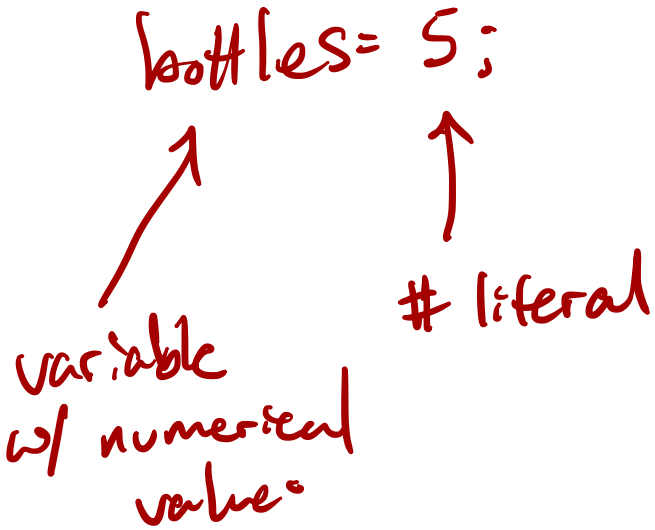
Variable definitions: more examples

Declaration	Comment
`int cans = 6;`	Defines integer `cans` and initializes it with value of 6
`int total = cans + bottles;`	Defines integer `total` and initializes with whatever cans+bottles equals. `cans` and `bottles` must have been previously defined and set
`int bottles = "10";`	**Error!** You cannot initialize the int `bottles` with the string "10". You could change this to `int bottles = 10;`
`int bottles;`	Defines an integer `bottles` without initializing it. This can lead to errors
`int cans, bottles;`	Defines two integer variables in a single statement. Neat!
`bottles = 1;`	**Caution!** The type is missing. This is *not* a definition, but an assignment of a new value to an existing variable.

Number types

Definition: A number written by a programmer is called a **number literal**.

There are some rules for writing literal values...



Number literals (Table 2)

Number	Type	Comment
6	int	An integer has no fractional part
-6	int	Integers can be negative
0	int	Zero is totes an integer
0.5	double	A number with a fractional part has type double
1.0	double	Defines two integer variables in a single statement. Neat!
1E6	double	A number in **exponential notation** (1×10^6, or 1000000) Numbers in exp. notation always have type double
2.96E-2	double	Negative exponent: 2.96×10^{-2}, or 0.0296. Fractional #, so double
100,000		**Error!** You cannot use a comma as a decimal separator
3 1/2		**Error!** You cannot use fraction/mixed numbers. Use decimal: 3.5

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Number literals (Table 2)

int, whole #s?

double ↑ fractions

1.5E3 = 1500

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Variable names

Life Lesson: Pick a name that explains the variable's purpose

Example: `int cans_per_pack = 6;`

"`cans_per_pack`" tells people **exactly** what that variable does. No BS.

You *could* have been stingy with the characters and called it "`cpp`" instead. But then it is unclear what the variable does, and people reading your code will eat their laptops.

Variable names -- some rules

Bottles bottles

1) Must start **with a letter or the underscore character** _
and remaining characters must be letters, numbers, or underscores.

2) **NO** symbols like $ or % or spaces.
But you can use an underscore (like `cans_per_pack`)

3) Variable names are **case-sensitive**
(so `cansperpack` and `cansPerPack` are different names)

4) You cannot use ***reserved words*** such as “double” or “return” as variable names.

(They are reserved exclusively for their special C++ meanings; see Appendix B for more reserved names)

Variable names -- some examples

Variable name	Comment
can_volume1	Variable names consist of all letters, numbers and underscores
x	In math, you use short variable names like *x* or *y*. This is legal in C++ but is not good practice because it makes programs harder to understand
Can_volume	**Caution!** Variable names are case sensitive. This variable name might get confused with can_volume
6pack	**Error!** Variable names cannot start with a number
can volume	**Error!** Variable names cannot contain spaces
double	**Error!** Contains a reserved word
ltr/fl.oz	**Error!** Cannot use symbols like . or /

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The assignment statement

- Contents in variables can ***vary*** over time
- Variables can be changed by
  - Assigning to them: `cans_per_pack = 6;`
  - Using the increment or decrement operators: ++ and -- respectively
  - Inputting into them: input statements (later!)

Example:

```
int cans_per_pack = -1;
cans_per_pack = 6;
cans_per_pack = 12;
cout << cans_per_pack << endl;
```

Good practice: initialize variables at ridiculous

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  - Assigning to them: `cans_per_pack = 6;`
  - Using the increment or decrement operators: ++ and -- respectively
  - Inputting into them: input statements (later!)

Example:

```
int cans_per_pack = -1;  // initializing cans_per_pack with value -1
cans_per_pack = 6;       // at this point in the code, cans_per_pack has the value 6
cans_per_pack = 12;      // this replaces cans_per_pack's value with 12
cout << cans_per_pack << endl;   // this will print a 12 to the screen
```

The assignment statement

Important distinction: **defining** vs **assigning**

- **Definition statement**: `int cans_per_pack = -1;`
  - Creates it, and possibly initializes it

- **Assignment statement**: `cans_per_pack = 6;`
  - Modifies an ***already existing*** variable
  - Contents are replaced with the new stuff (was -1, is now 6)

The *meaning* of the assignment statement

- We write: `cans_per_pack = 6;`
  - But the = does **not** mean the two sides are equal like it does in math
  - The = is an **instruction** -- it tells the computer to do something:
    - take the value of the expression on the right…
    - … and copy it into the variable on the left.

```
cans = 6;
cans = cans + 2;
```

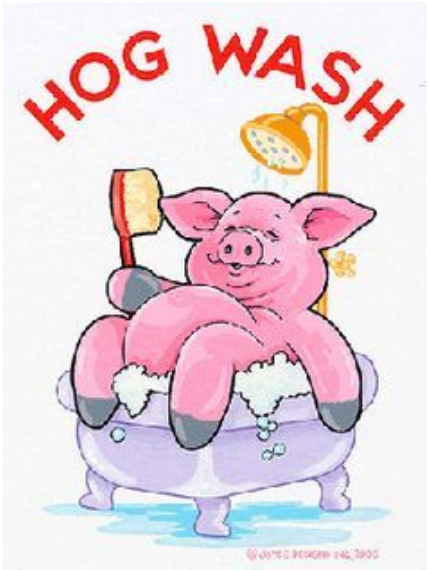
```
x = x+2
```

The *meaning* of the assignment statement

- We write: `cans_per_pack = 6;`
  - But the = does **not** mean the two sides are equal like it does in math
  - The = is an **instruction** -- it tells the computer to do something:
    - take the value of the expression on the right…
    - … and copy it into the variable on the left.
  - But what would it mean in math to state this?

    `counter = counter + 2;`
  - In math, that asks the question: does counter equal counter + 2?

    → Hogwash!



Assignment examples


```
counter = 1;                    // set counter to 1
counter = counter + 2;          // increment counter by 2
// now counter = 3
```

- The first statement assigns the value 1 to `counter`
- The second statement looks up what is currently in `counter` (1)...
- … then adds 2 to it and copies the result of this addition into the variable on the left
  - This changes the value of `counter` to 3

Assignment examples


```
counter = 1;          // set counter to 1
total = counter + 2;  // total is 2 more than whatever is in counter
```

- What about this one? What are the variables' values?

counter = 1

total = 3

- And what statements must have appeared earlier in the program?

```
int counter;
int total;
```

definitions

Constants

Sometimes we want to represent values that we know will not change during a run of our program.

- For this, we include the designation "`const`" in our variable declaration:

  Example: `const double CAN_VOLUME = 12;`

- A `const` is a variable whose contents cannot be modified and must be set when created (most folks call these "constants" and not "variables" to avoid confusion)
- Constants are commonly written using capital letters to distinguish them visually from regular variables

Constants

Constants are great when we want to be clear about the meaning of numbers in code!

Example:

```
double volume = cans * 12;
```

- It might be unclear what the 12 represents
- But if we use a `const` then there is no question:

```
const int CAN_VOLUME = 12;
double volume = cans * CAN_VOLUME;
```

Constants

Constants are great when we want to be clear about the meaning of numbers in code!

Another Example:

```
double volume_in_cans = cans * 12;
double eggs_total = cartons * 12;
```

- Do those 12's mean the same thing? Different things? WTF?
- It's bad programming practice to use these ***magic numbers***. Use constants instead.

Constants

Constants are great when we want to be clear about the meaning of numbers in code!

const int CAN_VOLUME = 12; 16

Nightmare Situation Example:

```
double volume_in_cans = cans * 12;
```

- Suppose we have thousands of lines of code, and the number 12 is used many times throughout the code.
- It might also be used in a ton of different contexts (cans, bottles, eggs, inches, …)
- What if we upgraded to 16-oz cans for our nondescript beverages?

  → Need to change only the `CAN_VOLUME` instances to 16

- How would we change only the right instances of 12?

Constants

Constants are great when we want to be clear about the meaning of numbers in code!

Nightmare Situation Example:

Constants to the rescue!

```
const double CAN_VOLUME = 16;
const double EGGS_PER_CARTON = 12;
...
double volume_in_cans = cans * CAN_VOLUME;
double eggs_total = cartons * EGGS_PER_CARTON;
```

Comments

Comments are brief explanations for human readers of your code (e.g., other programmers, your classmates, your instructors, your co-workers)

The compiler completely ignores any comments

A leading double slash // tells the compiler that the remainder of that line of code is a comment, so it should be ignored.

Example:

```
const double CAN_VOLUME = 16; // volume (fl oz) of a beverage can
```

Comments

Comments come in two varieties:

1) Single line, using //

```
const double CAN_VOLUME = 16;    // volume (fl oz) of a beverage can
```

Compiler ignores everything from // to end of the line

2) Multi-line, using /* [comment goes here] */

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

Compiler ignores everything between /* and */

Complete program: volume1.cpp

```
#include <iostream>
using namespace std;
/*
This program computes the volume (in liters) of a six-pack of soda
cans and the total volume of a six-pack and a two-liter bottle.
*/
int main()
{
   int cans_per_pack = 6;
   const double CAN_VOLUME = 0.355;                    // Liters in a 12-ounce can
   double total_volume = cans_per_pack * CAN_VOLUME;

   cout << "A six-pack of 12-ounce cans contains " << total_volume << " liters." << endl;

   const double BOTTLE_VOLUME = 2;                     // Two-liter bottle
   total_volume = total_volume + BOTTLE_VOLUME;

   cout << "A six-pack and a two-liter bottle contain " << total_volume << " liters." << endl;
   return 0;
}
```

Common error: using undefined variables

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

Example: The following sequence 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.

So when compiler reaches the first statement, it will freak out because it does not know what `liter_per_ounce` is.

Common error: using uninitialized variables

Initializing a variable is not required, but is good practice.

But all variables have ***some*** value, even uninitialized ones.

→ Variables are just some place in the computer's memory.

→ ***Something*** will be there, the junk left over from some previous calculation or simply the random value there when the transistors in RAM were first turned on.

→ Using an uninitialized variable is like picking a parking spot in a garage without knowing what's there. **Unpredictable.**

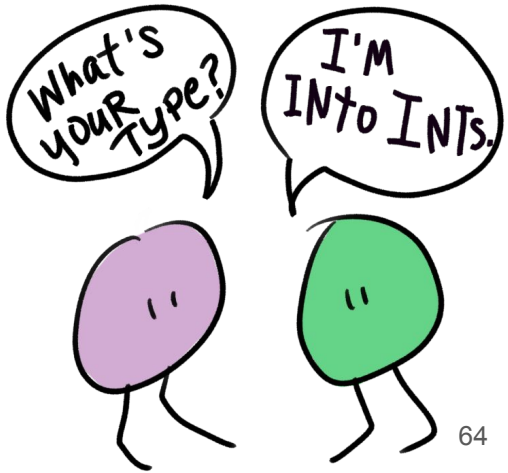
Examples:

```
int bottles;                          // Forgot to initialize
int bottle_volume = bottles * 2;      // What will this be?!?
cout << bottle_volume << endl;        // What will print to the screen?!?
```

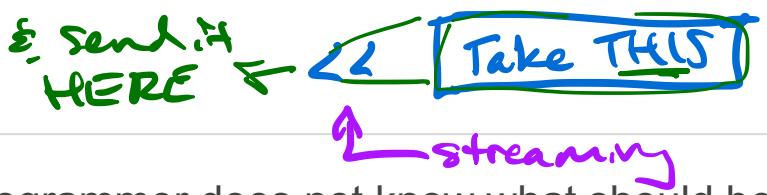
Chapter 2: Fundamental Data Types

Chapter topics:

- Variables
- Arithmetic
- Input and output
- Problem solving: first do it by hand
- Strings



Input



- Sometimes the programmer does not know what should be stored in a variable, but the user does
- The programmer must get the input value from the user
  - Users need to be prompted - how else would they know they need to type something?
  - Prompts are done in output (`cout`) statements
  - The keyboard needs to be read from (`cin`) statements

Input -- using `cin >>`

- Sometimes the programmer does not know what should be stored in a variable, but the user does
- The programmer must get the input value from the user
  - Users need to be prompted - how else would they know they need to type something?
  - Prompts are done in output (`cout`) statements
  - The keyboard needs to be read from (`cin`) statements

- To read values from the keyboard, you input them from an object called `cin`
- The “double greater than” operator `>>` denotes the “send to” command

Take this

```
cin >> bottles;
```
← takes keyboard input and sends it into the `bottles` variable

Input -- using `cin >>`

Example: Write some code to prompt the user to enter an integer number of bottles, and store this variable.

Input -- using cin >>

Example: Write some code to prompt the user to enter an integer number of bottles, and store this variable.

Display a prompt to the user

Don't use endl here so the input is on the same line as the prompt.

Solution:

```
cout << "Enter the number of bottles: ";

int bottles;

cin >> bottles;
```

Define a variable to hold the input value (could be above the cout statement)

Program waits for user input, then places it into the variable bottles

Input -- using cin >>

You can read more than one value in a single input statement:

```
cout << "Enter the number of bottles and cans: ";

cin >> bottles >> cans;
```

The user can supply both inputs on the same line:

```
Enter the number of bottles and cans:  2  6
```

Or the user can press Enter or Tab after each input, because cin treats all blank spaces the same

Formatted Output

We'll talk about this more ~~later~~! now!

- When you print an amount in dollars and cents, you generally want it to be *rounded* to two decimal places
- We saw earlier how to round off and store a value. But here, we only want to round for display purposes (and keep the more accurate number for calculations)
- A **manipulator** is something that is sent to `cout` to specify how values should be formatted
- To use manipulators, you must include the `iomanip` header and `namespace std`

```
#include <iomanip>
using namespace std;
```

Formatted Output -- fixed << setprecision()

Which do you think the user prefers to see on her gas bill?

1.21 = 1.210000...

- Price per liter: $1.22
- Price per liter: $1.21997

decimal places

Example: Including fixed << setprecision(2) (for example) will round to 2 decimal places:

```
price_per_liter = 1.21997

cout << fixed << setprecision(2) << "Price per liter: $" << price_per_liter << endl;
```

Formatted Output -- setw()

Use the setw manipulator to set the ***width*** of the next output field

The width is the total number of characters, including digits, the decimal point and spaces

If you want aligned columns of certain widths, this is your jam

Example: To print numbers, right justified, in columns that are 8 characters wide, you use:

```
cout << setw(8) << ...
```

8 chars.

before ***every*** column's data

Let's look at an **example**! Suppose we wanted to show a **data table** of some kind.

Formatted Output -- Examples

Given
```
int quantity = 10;
double price = 19.95;
```

What do the following statements print? *(represent leading spaces as underscores _)*

```
cout << "Quantity:" << setw(4) << quantity;
```
Quantity:__10

```
cout << "Price:" << fixed << setw(8) << setprecision(2) << price;

cout << "Price:" << fixed << setprecision(2) << price;

cout << fixed << setprecision(3) << price;

cout << fixed << setprecision(1) << price;
```

Persistence -- setw() vs setprecision()

There is a notable difference between setprecision and setw manipulators:

- Once you `setprecision`, that precision will be used for ***all*** floating-point numbers until the next time you set the precision

- `setw` only affects the ***next*** value

Formatted Output -- Examples (Table 7)

Output statement	Output	Comment
cout << 12.345678;	12.3457	
cout << fixed << setprecision(2) << 12.3;	12.30	
cout << ":" << setw(6) << 12;	: 12	
cout << ":" << setw(2) << 123;	:123	
cout << setw(6) << ":" << 12;	:12	

Formatted Output -- Examples (Table 7)

Output statement	Output	Comment
`cout << 12.345678;`	12.3457	By default, a number is printed with 6 significant digits (total, left+right of decimal pt)
`cout << fixed << setprecision(2) << 12.3;`	12.30	The `fixed` and `setprecision` manipulators control the # of digits after decimal pt
`cout << ":" << setw(6) << 12;`	: 12	4 spaces are printed before the number, total of 6 characters
`cout << ":" << setw(2) << 123;`	:123	Width isn't sufficient, so setw is ignored
`cout << setw(6) << ":" << 12;`	:12	Width only refers to **next item**, which is : Here, : is preceded by 5 spaces

A complete program for volumes!

Example: Write a complete program to take in the price of a six-pack of cans, and the volume of each can (in fluid ounces), and output to the screen the price per fluid ounce, rounding to two decimal places.

A complete program for volumes!

```
#include <iostream>
#include <iomanip>
using namespace std;

int main()
{
    // Read price per pack
    cout << "Please enter the price for a six-pack: ";
    double pack_price;
    cin >> pack_price;

    // Read can volume
    cout << "Please enter the volume for each can (in ounces): ";
    double can_volume;
    cin >> can_volume;
```

(continued on next slide)

A complete program for volumes!

(continued from previous slide)

```
   // Compute pack volume
   const double CANS_PER_PACK = 6;
   double pack_volume = can_volume * CANS_PER_PACK;

   // Compute and print price per ounce
   double price_per_ounce = pack_price / pack_volume;
   cout << fixed << setprecision(2);
   cout << "Price per ounce: " << price_per_ounce << endl;
   return 0;
}
```

What just happened…?

- We saw what a program looks like!
- We saw what are some common errors!
- We saw some debugging strategies!
- We saw some ways to write good, wholesome, human-readable code!
- We learned how to represent numerical variables!
- We learned how to input information into the computer,
  and get information back out!
  → `cin >>` & `cout <<`
- We saw how to manage **input** from keyboard and **output** to screen!
  → `fixed << setprecision(##)` and `setw(##)`

Your first program

The classic first program everyone writes: Hello world!

Its job is to write the message “Hello world!” to the screen

Before we dive in, let’s all code it together!

You can code stuff however you want. Working off the CSEL server in JupyterLab is a nice alternative to Cloud9.

1) https://coding.csel.io
2) Sign in with CU Identikey credentials
3) “Start my server”
4) Open a Terminal and a Text Editor
   (might need to open a New Launcher by going to File → Open New Launcher)