C++ Basics

Announcements

Lab 1 this week!

Homework posted Thursday
    -Due next Thursday at 11:55pm

Variables

Variables are objects in program

To use variables two things must be done:

- Declaration
- Initialization

See: uninitialized.cpp

Example if you forget to initialize:

```
I am 0 inches tall.
I am -1094369310 inches tall.
```

Variables

```
int x, y, z;   ←  Declaration
x = 2;  ⎫
y = 3;  ⎬  Initialization
z = 4;  ⎭
```

Same as:

```
int x=2, y=3, z=4;
```

Variables can be declared anywhere (preferably at start)

Assignment operator

= is the assignment operator

The object to the right of the equals sign is stored into the object in the left

```
int x, y;
y = 2;
x = y+2;
```

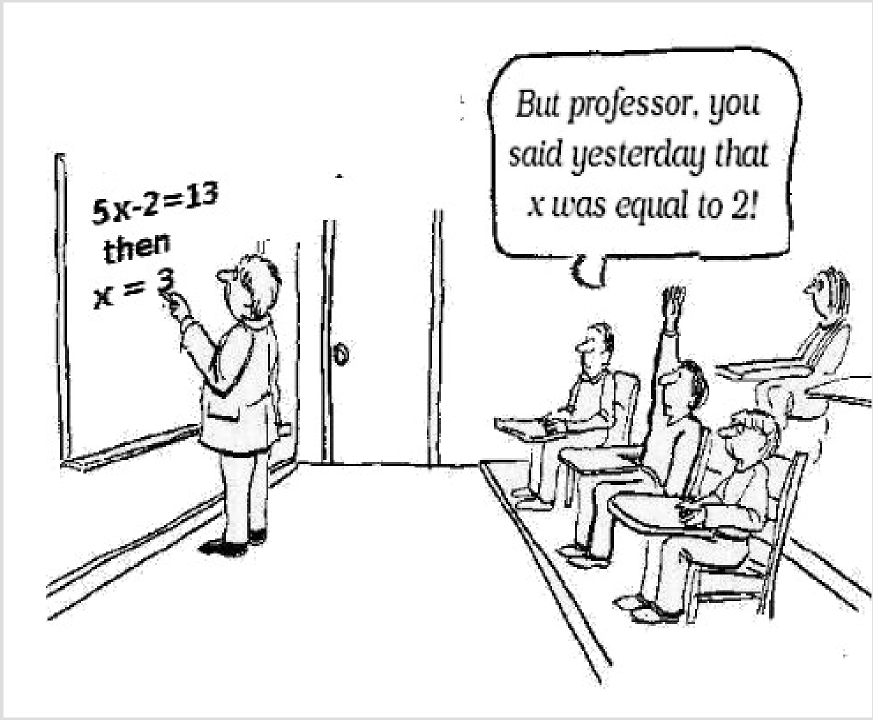
See: assignmentOp.cpp

Assignment operator

= is NOT a mathematic equals

```
x=3;
x=4;  // computer is happy!
```

This does not mean 3=4



Assignment operator

To the left of = needs to be a valid object that can store the type of data on the right

```
int x;
x=2.6; // unhappy, 2.6 is not an integer

x+2 = 6; // x+2 not an object

2 = x; // 2 is a constant, cannot store x
```

Assignment operator

What does this code do?

```
int x = 2, y = 3;
y=x;
x=y;
```

What was the intention of this code?

Increment operators

What does this code do?

```
int x = 2;
x=x+1;
```

Same as:

```
x+=1;
   or
x++;
```

Increment operators

Two types of increment operators:

```
x++;  // increments after command
   vs
++x;  // increments before command
```

Complex assignments

The following format is general for common operations:

variable (operator)= expression
variable = variable (operator) expression

Examples:

```
x+=2          x = x + 2
x*=y+2        x = x * (y + 2)
```

$\Longleftrightarrow$

Order of operations

Order of precedence (higher operations first):
-, +, ++, -- and ! (unary operators)
*, / and % (binary operators)
+ and - (binary operators)

% is remainder operator
(example later in simpleDivision.cpp)

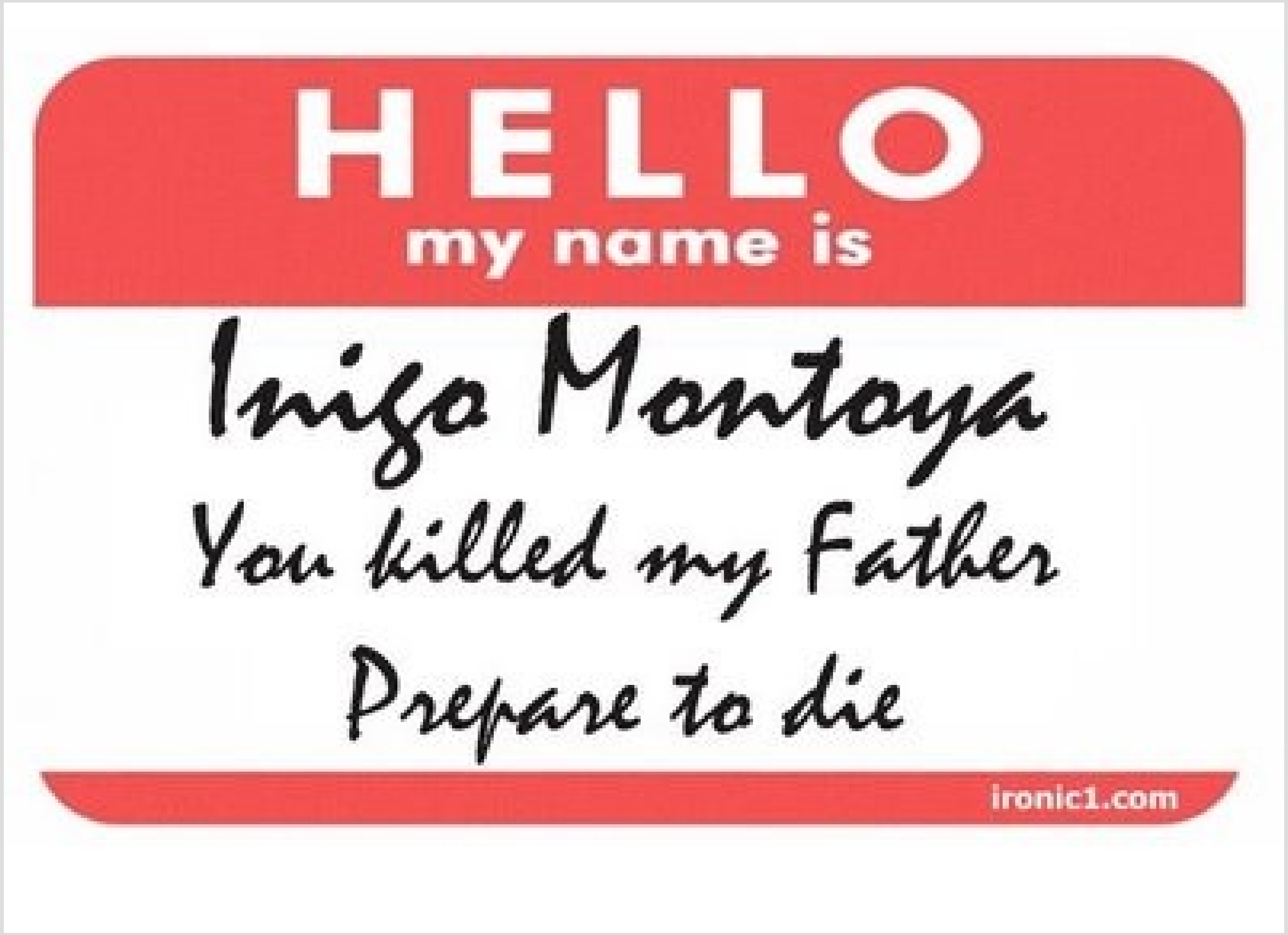
Order of operations

Binary operators need two arguments
Examples:
2+3, 5/2 and 6%2

Unary operators require only one argument:
Examples: (see binaryVsUnaryOps.cpp)
+x, x++, !x

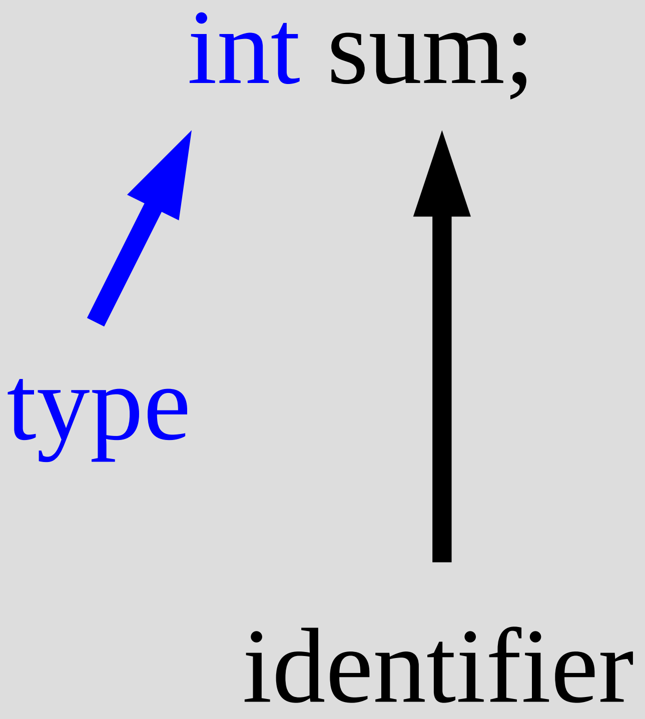
(! is the logical inversion operator for bool)

Identifiers



Identifiers

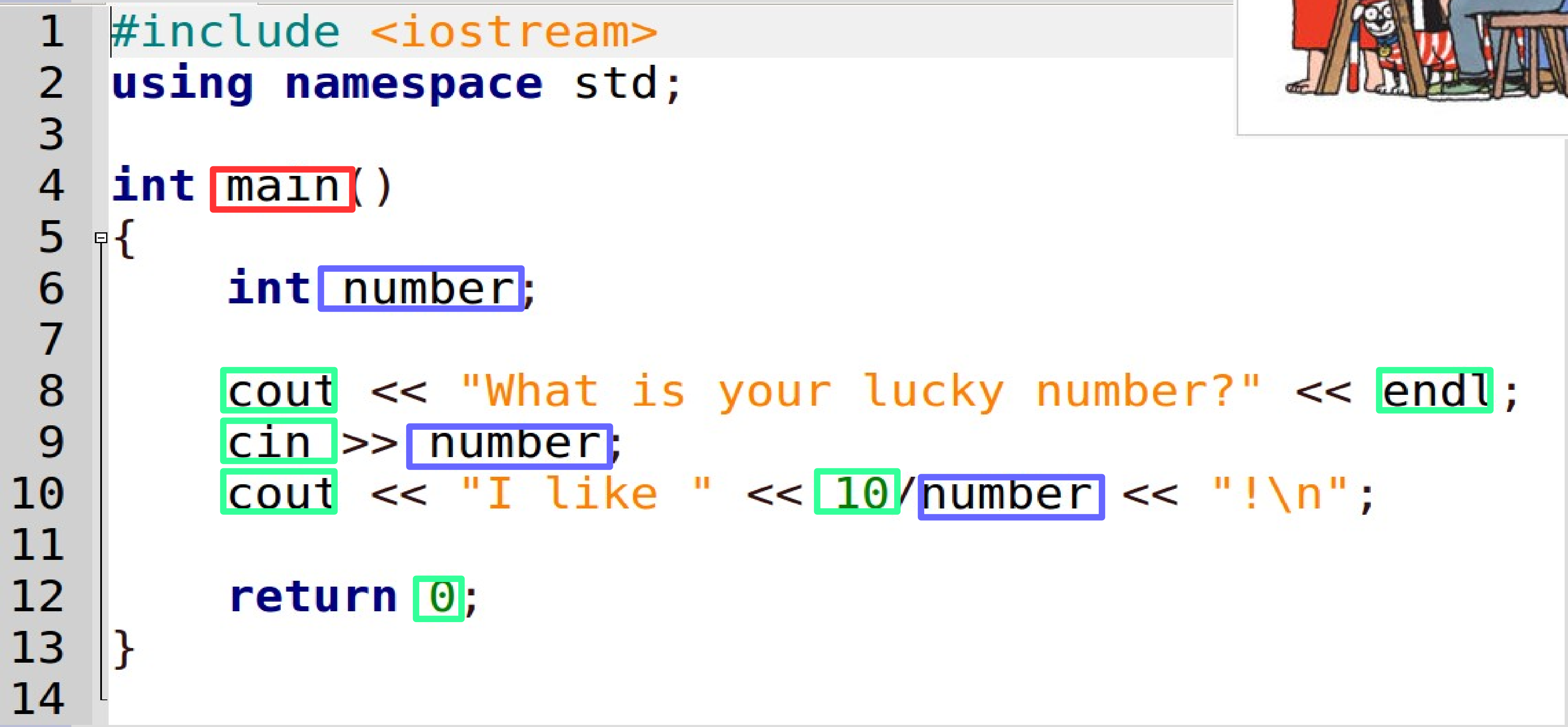
An identifier is the name of a variable (or object, class, method, etc.)



- Case sensitive
- Must use only letters, numbers or _
- Cannot start with a number
- (Some reserved identifiers, like main)

Identifiers

Already did this in week 1!
See: RuntimeError.cpp



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

int main()
{
    int number;

    cout << "What is your lucky number?" << endl;
    cin >> number;
    cout << "I like " << 10/number << "!\n";

    return 0;
}
```

Identifiers

Which identifiers are valid?

1) james parker
2) BoByBoY
3) x3
4) 3x
5) x_________
6) _________x
7) Home.Class
8) Five%
9) x-1

Identifiers

Which identifiers are valid?

~~1) james parker~~

2) BoByBoY

3) x3

~~4) 3x~~

5) x_________

6) _________x

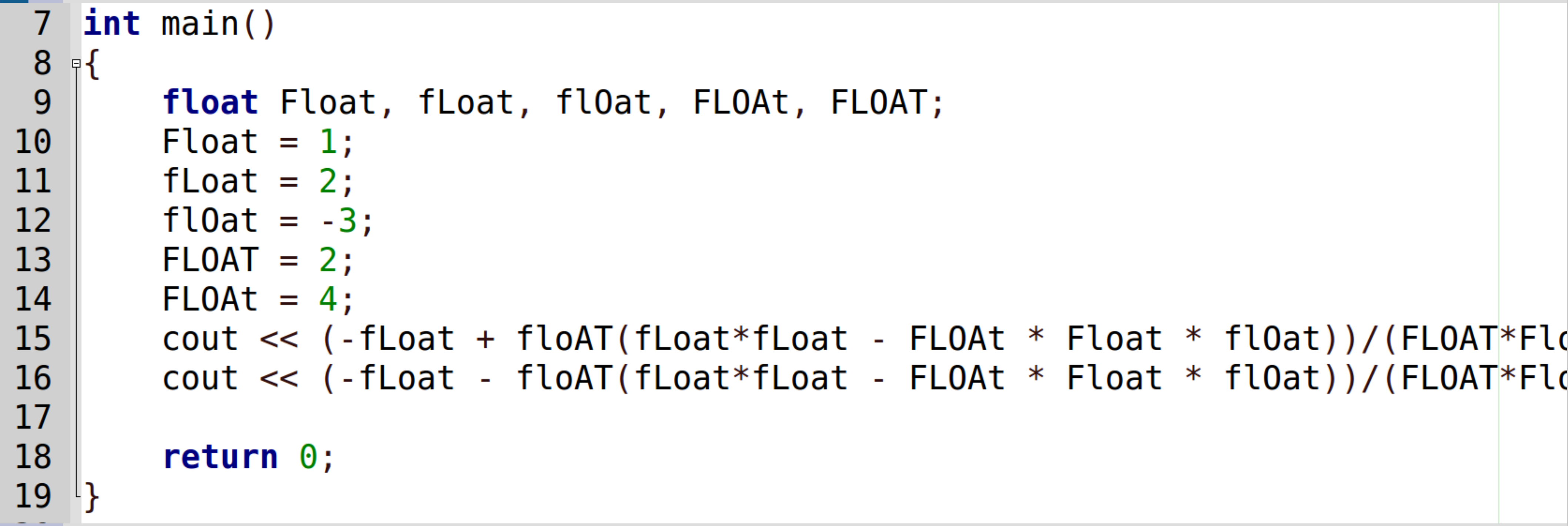
~~7) Home.Class~~

~~8) Five%~~

~~9) x-1~~

Identifiers

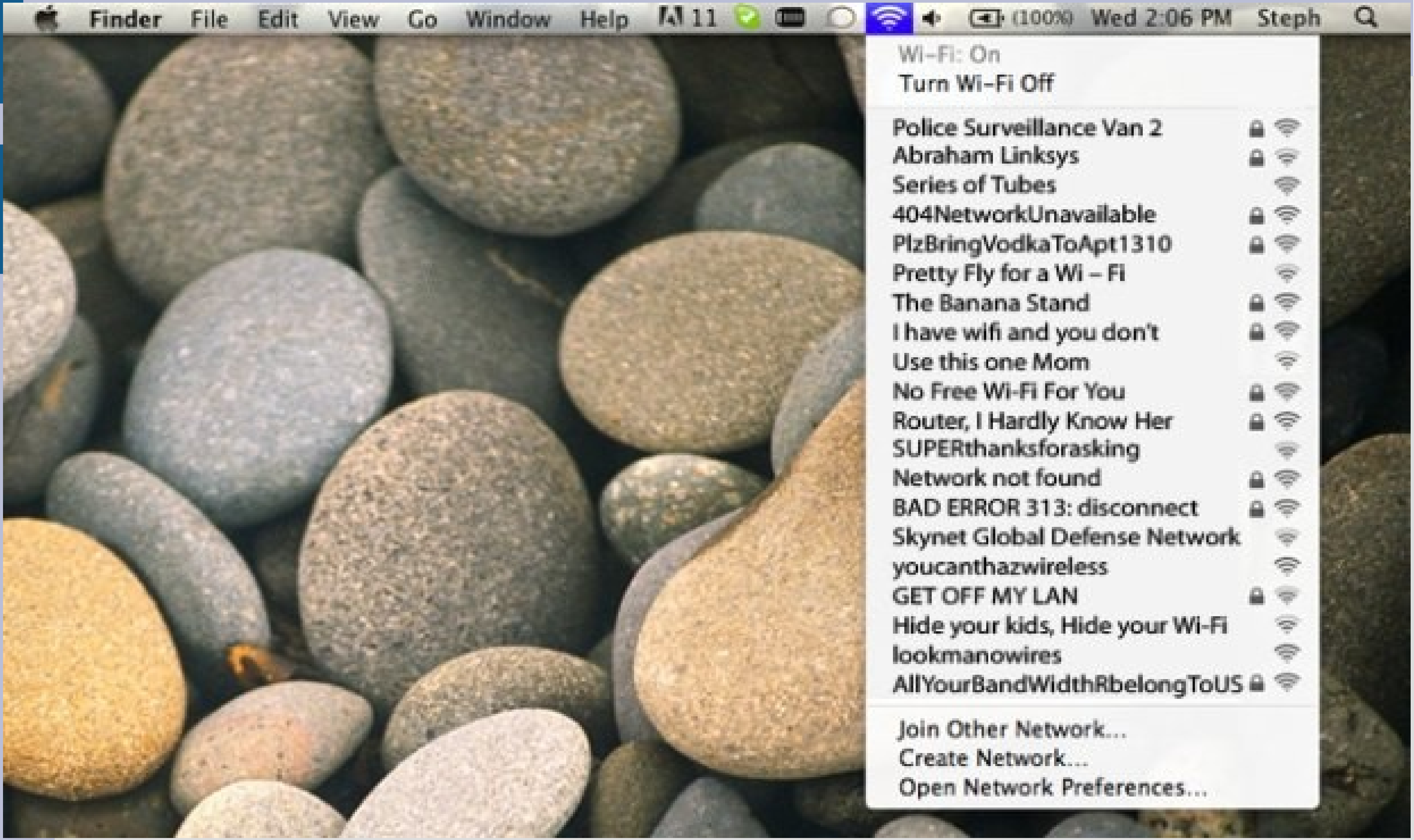
(See: float.cpp)



```
int main()
{
    float Float, fLoat, fl0at, FLOAt, FLOAT;
    Float = 1;
    fLoat = 2;
    fl0at = -3;
    FLOAT = 2;
    FLOAt = 4;
    cout << (-fLoat + floAT(fLoat*fLoat - FLOAt * Float * fl0at))/(FLOAT*Fl
    cout << (-fLoat - floAT(fLoat*fLoat - FLOAt * Float * fl0at))/(FLOAT*Fl

    return 0;
}
```

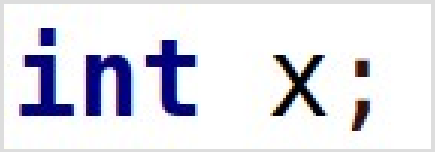
Identifiers



Police Surveillance Van 2
Abraham Linksys
Series of Tubes
404NetworkUnavailable
PlzBringVodkaToApt1310
Pretty Fly for a Wi – Fi
The Banana Stand
I have wifi and you don't
Use this one Mom
No Free Wi-Fi For You
Router, I Hardly Know Her
SUPERthanksforasking
Network not found
BAD ERROR 313: disconnect
Skynet Global Defense Network
youcanthazwireless
GET OFF MY LAN
Hide your kids, Hide your Wi-Fi
lookmanowires
AllYourBandWidthRbelongToUS

Variables

We (hopefully) know that if you say:



```
int x;
```

You ask the computer for a variable called x

Each variable actually has an associated <u>type</u> describing what information it holds (i.e. what can you put in the box, how big is it, etc.)

Fundamental Types

bool - true or false
char - (character) A letter or number
int - (integer) Whole numbers
long - (long integers) Larger whole numbers
float - Decimal numbers
double - Larger decimal numbers

See: intVSlong.cpp

int vs long?

int - Whole numbers in the approximate range:
-2.14 billion to 2.14 billions (10^9)

long - Whole numbers in the approximate range:
-9.22 quintillion to 9.22 quintillion (10^{18})

Using int is standard (unless you really need more space, for example scientific computing)

float vs double?

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float vs double?

float is now pretty much obsolete.

double takes twice as much space in the computer and 1) has wider range and 2) is more precise

Bottom line: use double (unless for a joke)

float and double

Both stored in scientific notation

```
double x = 2858291;
```

Computer's perspective:

x = 2.858291e6

or

$x = 2.858291 * 10^6$

Welcome to binary

Decimal:	Binary:
1/2 = 0.5	0.1
1/3 = 0.3333333	0.010101010101
1/10 = 0.1	0.0001100110011

double is often just an approximation!

Numerical analysis

Field of study for (reducing) computer error

See: subtractionError.cpp

Can happen frequently when solving system of linear equations

bool

You can use integers to represent bool also.

false = 0
true = anything else

(You probably won't need to do this)

int or double?

If you are counting something (money),
use int

If you are dealing with abstract concepts (physics),
use double

int doesn't make “rounding” mistakes

Primitive type hierarchy

bool < int < long < float < double

If multiple primitive types are mixed together in a statement, it will convert to the largest type present

Otherwise it will not convert type

Primitive type hierarchy

```
int x;
double y;

x+y
```

Converted to double

```
int x;
int y;

x/y
```

Not converted (still int)

Integer division

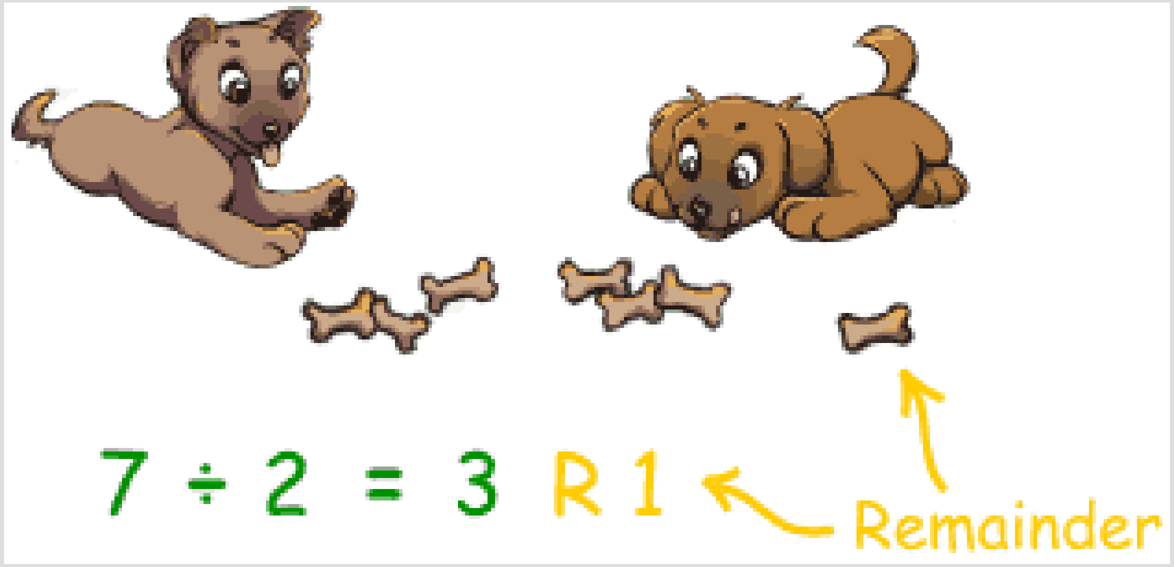
See: simpleDivision.cpp

Can be fixed by making one a double:

    1/2.0

or

    static_cast<double>(1)/2



Constants

You can also make a “constant” by adding const before the type

This will only let you set the value once

```
const double myPI = 3.14;
myPI = 7.23;  // unhappy computer!
```

Functions

Functions allow you to reuse pieces of code (either your own or someone else's)

Every function has a return type, specifically the type of object returned

sqrt(2) returns a double, as the number will probably have a fractional part

The “2” is an argument to the sqrt function

Functions

Functions can return void, to imply they return nothing (you should not use this in an assignment operation)

The return type is found right before the functions name/identifier.

int main() { ... means main returns an int type, which is why we always write return 0 and not return 'a' (there is no char main())

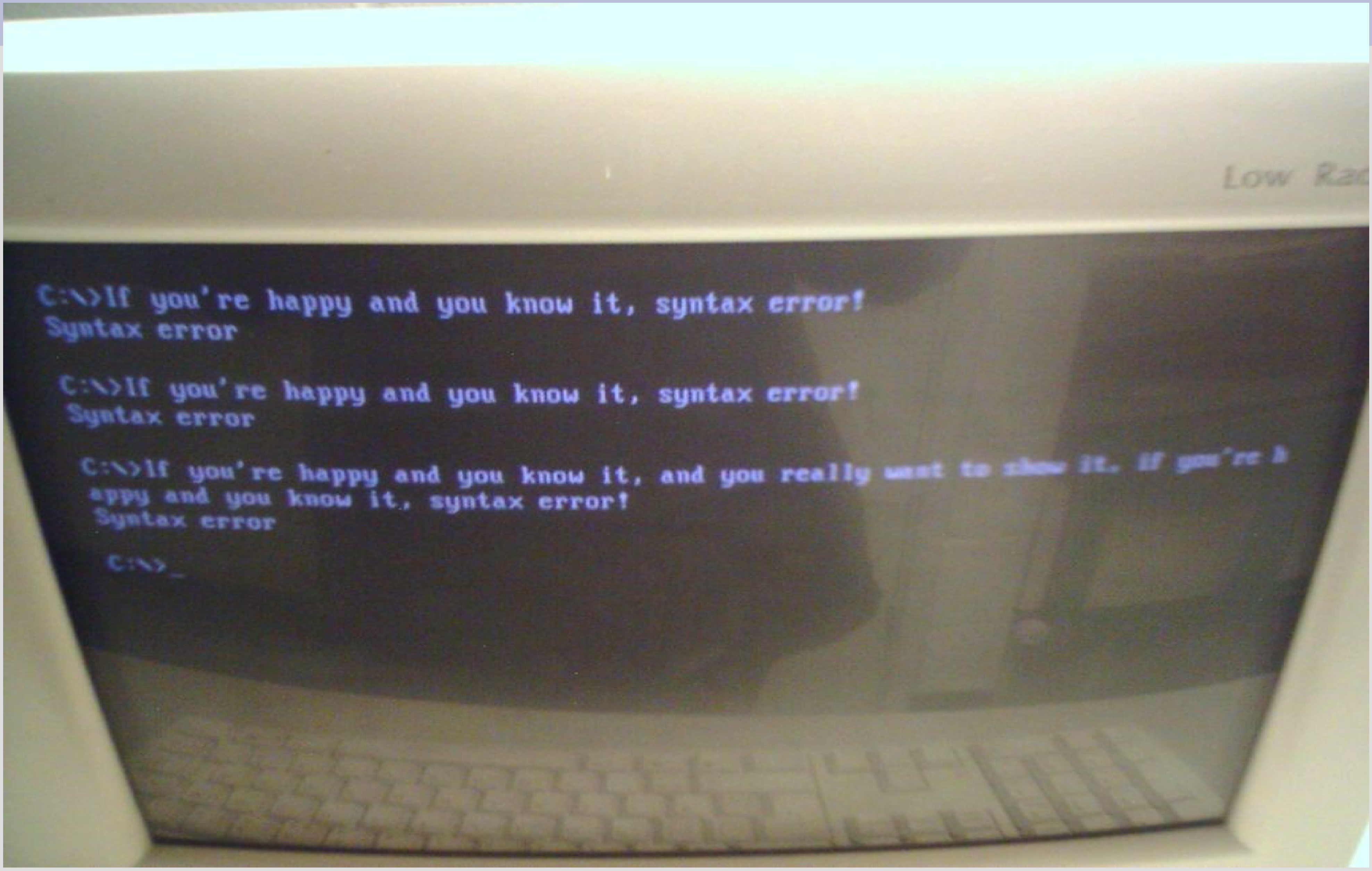
Functions

A wide range of math functions are inside <cmath> (get it by #include <cmath>; at top)

We can use these functions to compute Snell's Law for refraction angle

(See: math.cpp)

Input and output



```
C:\>If you're happy and you know it, syntax error!
Syntax error

C:\>If you're happy and you know it, syntax error!
Syntax error

C:\>If you're happy and you know it, and you really want to show it. If you're h
appy and you know it, syntax error!
Syntax error

C:\>_
```

Strings and input

char can only hold a single letter/number,
but one way to hold multiple is a string

```
string str;
cin >> str;
```

The above will only pull one word,
to get all words (until enter key) use:

```
getline(cin, str);
```

(See: stringInput.cpp)

More Output

When showing doubles with cout, you can change how they are shown

For example, to show a number as dollars and cents, you would type (before cout):

```
cout.setf(ios::fixed);
cout.setf(ios::showpoint);
cout.precision(2);
```

More Output

There are two ways to get output to move down a line: endl and “\n”

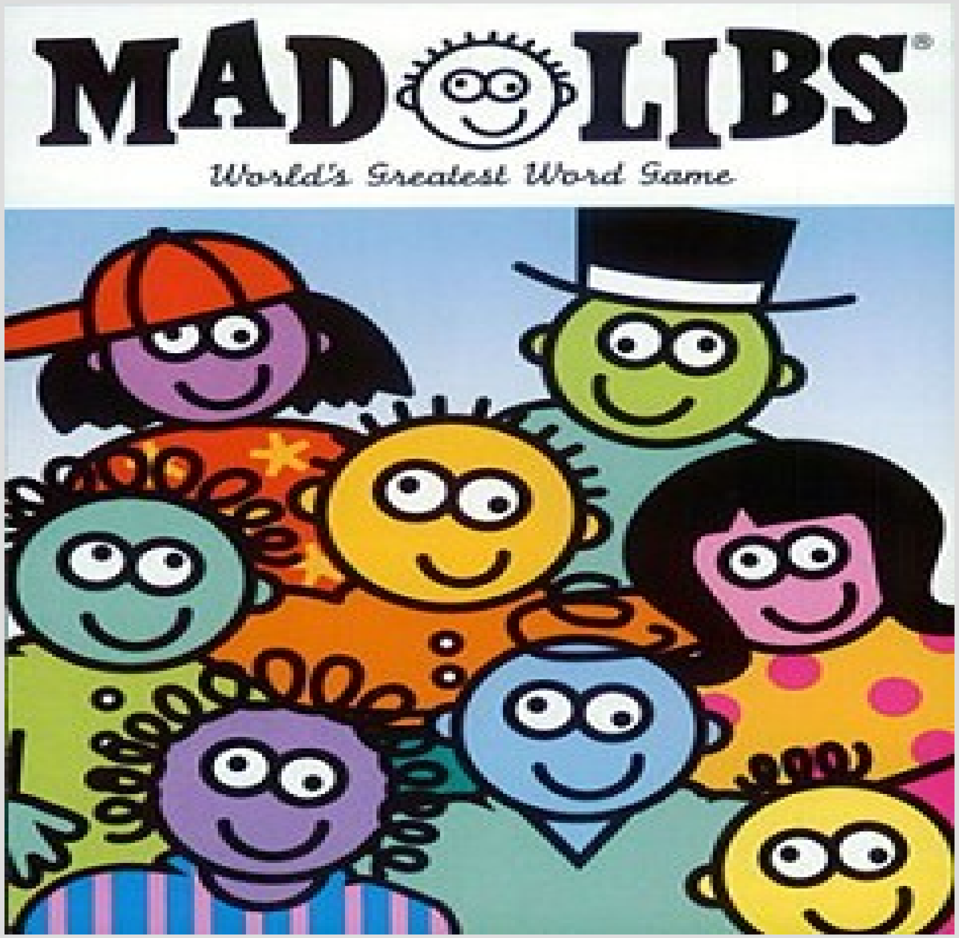
```
    cout << endl;
```

... is the same as...

```
    cout << “\n”
```

I will use both when coding

Madlibs



(see: madlibs.cpp)

bool

bool - either true or false

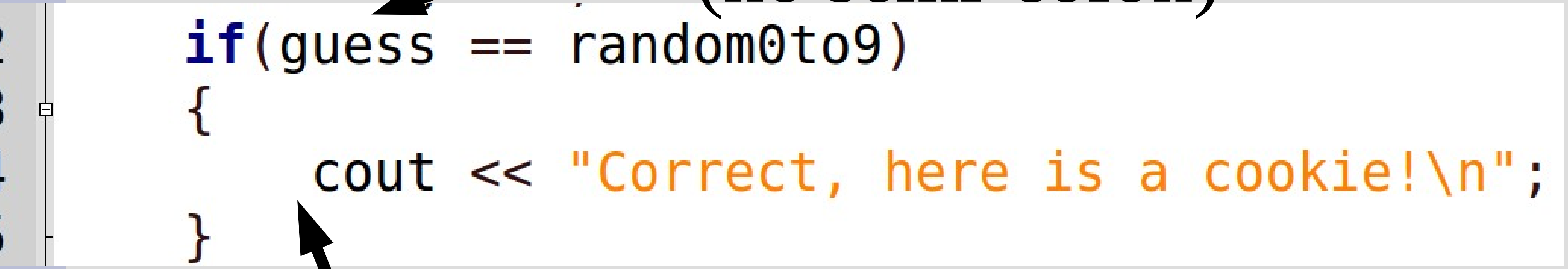
We will use the following today:

- > (greater than), e.g. 7 > 2.5 is true
- == (equals), e.g. 5 == 4 is false
- <= (less than or eq), e.g. 1 <= 1 is true

if statement

Code inside an if statement is only run if the condition is true.

Need parenthesis
(no semi-colon)



```
if(guess == random0to9)
{
    cout << "Correct, here is a cookie!\n";
}
```

Indent

(See: numberGuessing.cpp)

if/else statement

Immediately after an if statement,
you can make an else statement

If the “if statement” does not run,
then the else statement will

If you do not surround your code with braces
only one line will be in the if (and/or else)
statement

Double trouble!

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The Race and Chase Game of Twists and Turns
Ages 5 and Up
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Just press a bubble and your number's up! No loose dice.

(See: doubleCompare.cpp)

Double trouble!

When comparing doubles, you should use check to see if relative error is small:

fabs((x-y)/x) < 10E-10
(double has about 16 digits of accuracy so you could go to 10E-15 if you want)

For comparing Strings, use: (0 if same)
string1.compare(string2)

Loop

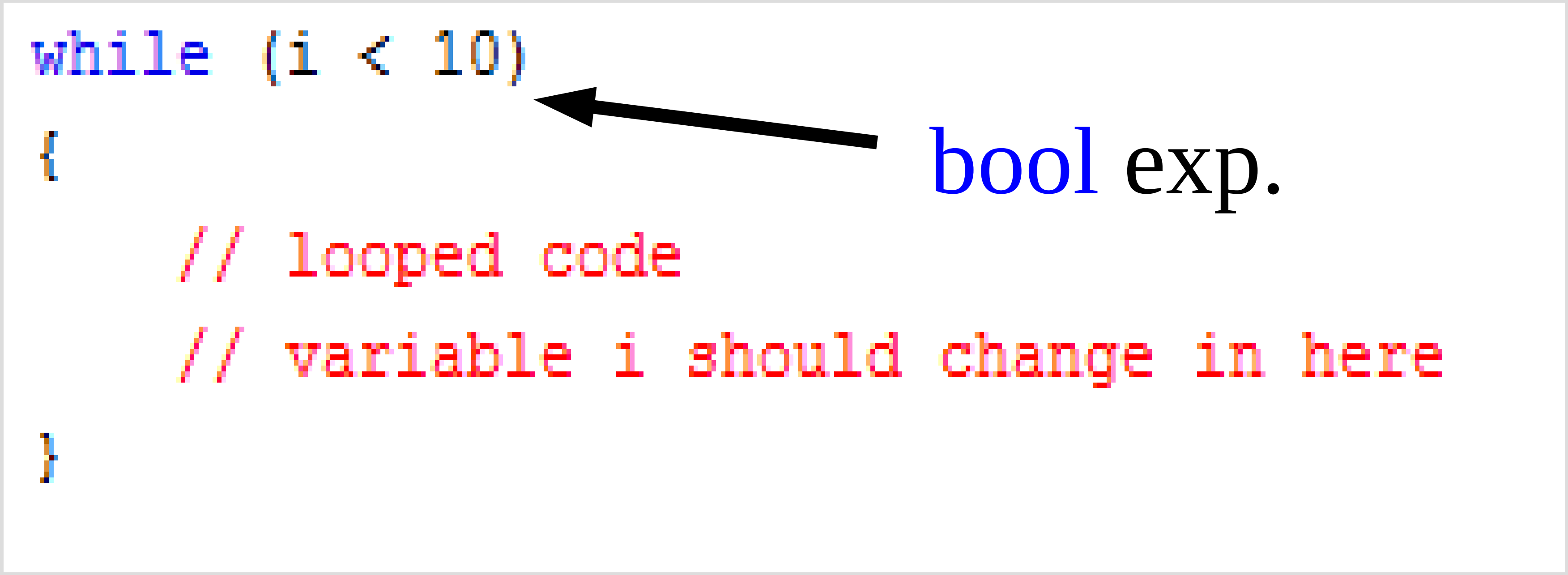
Often we want to do a (similar) command more than once

Computer programmers call this code a loop

Loops are quite powerful and are very commonly used

while loop

A while loop tests a bool expression and will run until that expression is false



```
while (i < 10)
{
    // looped code
    // variable i should change in here
}
```

(See: whileLoop.cpp)

while loop

The bool expression is tested when first entering the while loop

And!

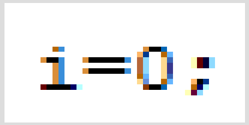
When the end of the loop code is reached (the } to close the loop)

```
int i = 0;
while (i < 5) {
    cout << "Looping, i = " << i << "\n";
    i++;
}
cout << "Outside the loop, i = " << i << "\n";
```

while loop

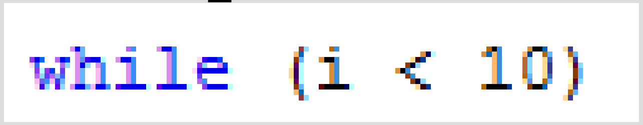
3 parts to any (good) loop:

- Test variable initialized



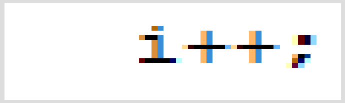
```
i=0;
```

- bool expression



```
while (i < 10)
```

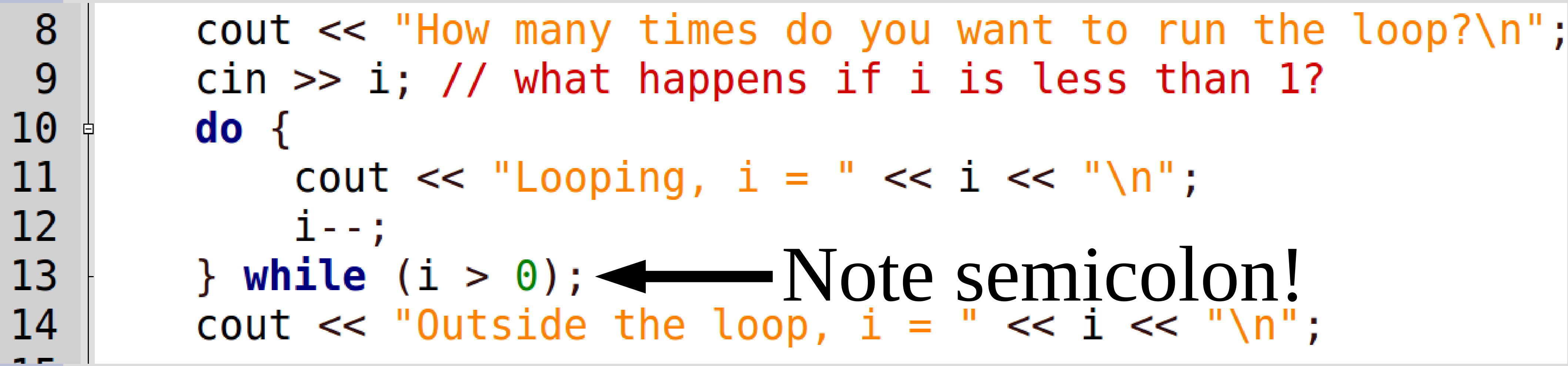
- Test variable updated inside loop



```
    i++;
```

do-while loop

A do-while loop is similar to a normal while loop, **except** the bool expression is only tested at the end of the loop (not at the start)



```
    cout << "How many times do you want to run the loop?\n";
    cin >> i; // what happens if i is less than 1?
    do {
        cout << "Looping, i = " << i << "\n";
        i--;
    } while (i > 0);
    cout << "Outside the loop, i = " << i << "\n";
```

Note semicolon!

(See: doWhile.cpp)

do-while loop

Q: Why would I ever want a do-while loop?

A: When the first time the variable is set is inside the loop.

You can initialize the variable correctly and use a normal while loop, but this makes the logic harder

Semi-colons

When to put semi-colons?

You put semi colons after every statement, except if you (should) start a block

Blocks should start after functions, if-statements and loops, thus these should not have semi colons after them