Types

There are only 10 types
of people in this world;
those who understand binary
and those who don't.

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?

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

bool - either true or false

You have the common math comparisons:

- > (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

Note: double equals (==) asks a question, a single equals (=) changes values

bool

You can use integers to represent bool also.

false = 0
true = anything else (1 is what is stored)

(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

Double trouble!

(See: doubleTrouble.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)

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

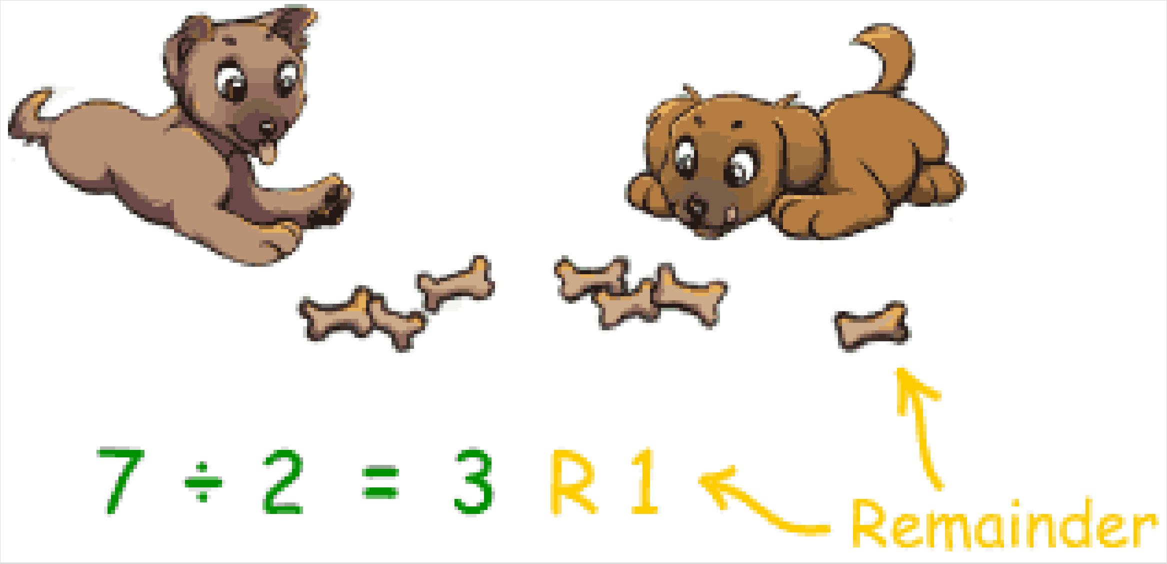
See: simpleDivision.cpp

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)