PIC 10A: Week 2b

Section 1C, Spring 2016

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v1.0

Announcements

- HW1 released, due April 13th (Next Wednesday, 11 PM)
  - Spec (pdf) is on course webpage, under "Course Work"
  - http://www.math.ucla.edu/~mikel/teaching/pic10a/
  - Link is protected by username/password
  - See: ccle Week 3 for login credentials
  - Submit online at ccle.ucla.edu

Today

- Numeric Data types
  - int, long long, double
- Base 2, Base 10
- Practice problems
  - work with people around you

int vs double

- In C++, there are several data types used for numeric data
- Two common types are: `int` and `double`

```
#include <iostream>
using namespace std;
int main() {
    int myage = 26;
    double myheight = 5.7;
    cout << "I am " << myage << " years old." << endl;
    cout << "I am " << myheight << " feet tall.";
    return 0;
}
```

Output:

```
I am 26 years old.
I am 5.7 feet tall.
```

int

- In C++, "int" is a data type used to store integer quantities
  - Ex: -42, -1, 0, 4, 9000
- Can't store fractional values!
  - C++ will truncate any fractions

```
int x = 42.3;
int y = 1.99;

cout << "x: " << x << " y: " << y;
```

Question: What is the output?

Output:

```
x: 42 y: 1
```

int: range

- int has a limited representation range
- On most modern machines, an int consists of 32 binary bits
- Range: –2,147,483,648 to 2,147,483,647
  - 2^(31) to 2^(31)-1
- If the range is exceeded, then resulting value is unreliable
  - Technical term: signed integer overflow has undefined behavior.

int: exceeding range

```
#include <iostream>
#include <cmath> // for pow
using namespace std;
int main() {
    int x = pow(2.0, 31)-1; // largest positive int
    int y = 1;
    int z = x + y; // exceed int range!
    cout << "x: " << x << endl;
    cout << "y: " << y << endl;
    cout << "x + y = " << z << endl;
    return 0;
}
```

Output:

```
x: 2147483647
y: 1
x + y = -2147483648
```

Became a negative number! Wow!

double

- A data type to store rational numbers (ie numbers with fractions)
  - Ex: 3.14, 9.0, 42.84
- Has a finite range, and finite precision
- Range: -1.7E+308 to +1.7E+308
- Precision: About 16 decimal digits

Mixing int's and double's

- Be wary when setting a double value to an int variable:

Example:

```
int x = 42;
double y = 3.6;
int z = x + y;
double a = x + y;
```

Question: What is z and a?

Answer: z is 45, a is 45.6

Mixing int's and double's

- Can operate on both int's and double's at the same time
- Generally, the resulting value is promoted to the more expressive data type

Example:

```
int x = 42;
double y = 3.6;
cout << (x+y);
```

Question: What is the output?

Answer: 45.6

Example:

```
int x = 3;
cout << (x/2);
```

Question: What is the output?

Answer: 1

long long

- Like int, but is larger
  - Storage: 8 bytes
  - Range: -10^19 to +10^19
    - Recall: int range is -2 billion to +2 billion
- Can mix/match int, long long, and double
- Example:

```
long long x = 42;
int y = 10;
double z = 1.5;
cout << x + y << endl; // Displays: 52
cout << x + z << endl; // Displays: 43.5
```

unsigned integers

- By default, integer data types (int, long long) are signed integers
  - Ex: Can set an int to -42, or +100.
- Can declare that a variable takes on only **positive** values via `unsigned`
  - `unsigned int, unsigned long long`
- `Example:`

```
unsigned int x = 10; // x can only have positive values
x = 0; // 0 is still valid
x = x - 10; // Warning! Weirdness happens
```

Setting an unsigned integer to a negative number results in the value wrapping around to a large negative number. Is almost always a bug that will cause your program to do weird things.

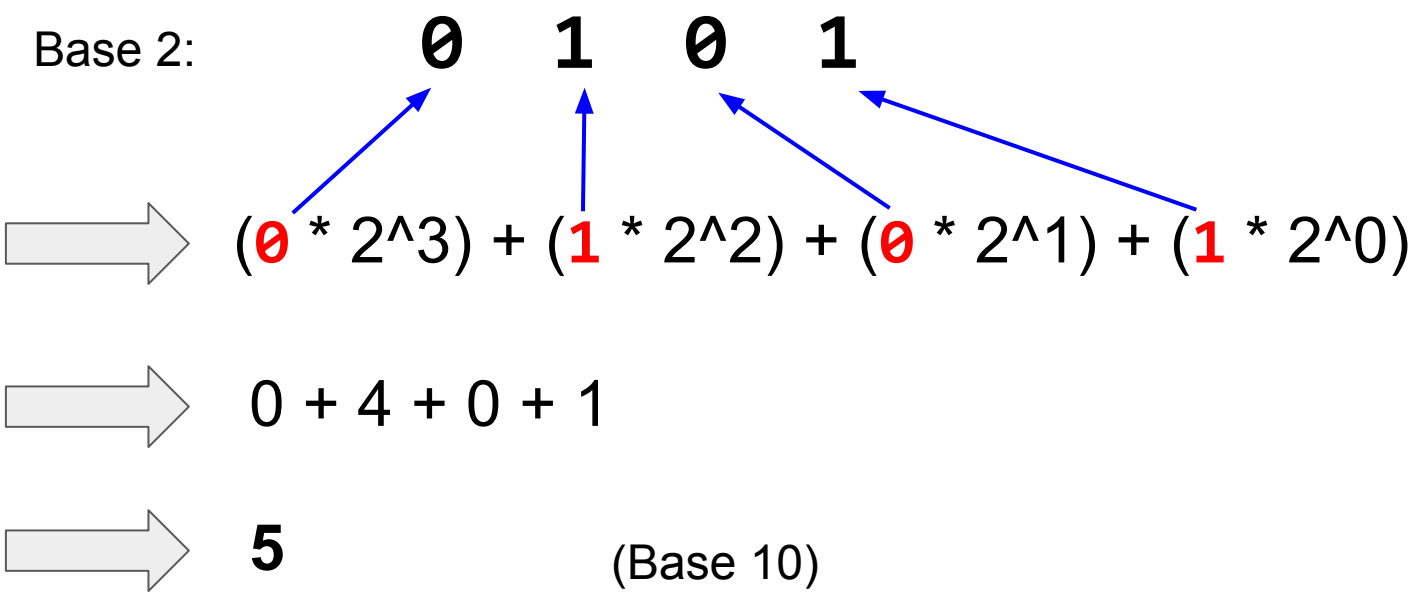
Base 2

- Binary: bunch of 0's and 1's
- We can encode *any* integer in base 2

Decimal (base 10)	Binary (base 2)
0	0000
1	0001
2	0010
3	0011
4	0100

etc...

Base 2: Converting to decimal



Practice Problems!

- Spend next ~15 minutes on exercises (hand out)
- Feel free to work with others around you!