Randomness

CS 1044

Randomness

- **Randomization** is heavily used in computer programs
- **Games** are probably the most obvious application
- Want to give the player a different experience every time

Determinism

- Computers are **deterministic** machines
- Meaning: Nothing they ever do is truly random, with the exception of interference from physical phenomena (like a short circuit)
- **Punchline:** Without external help, a computer **cannot** generate truly random numbers

Pseudo-Random Numbers

- Instead, computers use mathematical formulas to generate sequences of numbers that appear close enough to random to the average eye
- These are called **pseudo-random numbers**
- Given enough information, the sequence could be predicted, but probably only by Dustin Hoffman in *Rain Man*

Getting a Random Number

```
#include <cstdlib>
```

```
int x = rand();
```

- Generates a random integer between 0 to `RAND_MAX` (inclusive)
- `RAND_MAX` is a pre-defined constant guaranteed to be at least 32,767 – you don't usually need to worry about its exact value

Numbers in a Range

- There's no built-in function to get a number "between x and y" – you have to do a little math
- Use % (remainder) to restrict the range

```
int x;
x = rand();           // between 0 and RAND_MAX
x = rand() % 6;       // between 0 and 5
x = rand() % 6 + 1;   // between 1 and 6
```

- In general, to generate a number between `lo` and `hi`:

```
rand() % (hi - lo + 1) + lo
```

The Need for a Seed

- Run a program **multiple times** that generates some random numbers
- You'll get the **same sequence** of numbers every time!
- We need to **seed** the generator – an initial value that the formulas use to generate the remaining numbers
- What to use as the seed?

System Time

- We want a seed value that is guaranteed to be different **every time** the program runs
- The **system clock** is a good one

```
int t = time(0);
```

- `time` returns the number of seconds since midnight, January 1, 1970 (GMT)
- Don’t worry about the argument, just use 0

Planting the Seed

- The `srand` function takes the seed as its argument
- Write this once at the beginning of your `main` function and you'll get better random numbers

```
srand(time(0));
```