Week 13 - Friday

CS222

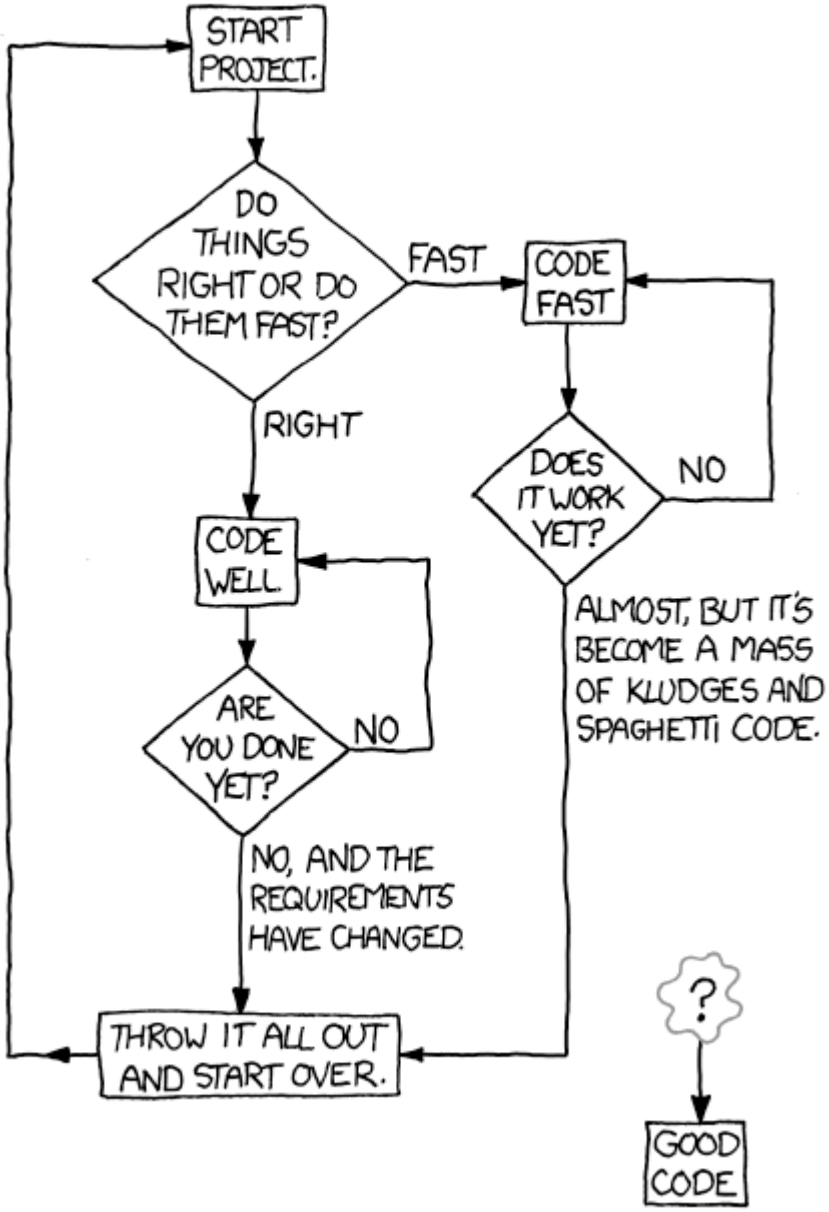
Last time

- What did we talk about last time?
- Networking practice

Questions?

Project 6

HOW TO WRITE GOOD CODE:



Function Pointers

Function pointers

- C can have pointers to functions
- You can call a function if you have a pointer to it
- You can store these function pointers in arrays and structs
- They can be passed as parameters and returned as values
- Java doesn't have function pointers
  - Instead, you pass around objects that have methods you want
  - C# has delegates, which are similar to function pointers

Why didn't we cover these before?

- K&R group function pointers in with other pointers
- I put them off because:
  - They are confusing
  - The syntax to declare function pointer variables is awful
  - They are not used very often
  - They are not type-safe
- But you should still know of their existence!

Declaring a function pointer

- The syntax is a bit ugly
- Pretend like it's a prototype for a function
  - Except take the name, put a * in front, and surround that with parentheses

```
#include <math.h>
#include <stdio.h>

int main()
{
	double (*root) (double); //pointer named root
	root = &sqrt; //note there are no parentheses
	printf( "Root 3 is %lf", root(3) );
	printf( "Root 3 is %lf", (*root)(3) ); //also legal


	return 0;
}
```

A more complex example

- Some function's prototype:

```
int** fizbin(char letter, double length, void* thing);
```

- Its (worthless) definition:

```
int** fizbin(char letter, double length, void* thing)
{
    return (int**)malloc(sizeof(int*)*50);
}
```

- A compatible function pointer:

```
int** (*pointer)(char, double, void*);
```

- Function pointer assignment:

```
pointer = fizbin;
```

Two styles

- Just to be confusing, C allows two different styles for function pointer assignment and usage

```
#include <math.h>
#include <stdio.h>

int main()
{
      int (*thing) (); //pointer named thing
      thing = &main; //looks like regular pointers
      thing = main; //short form with & omitted

      (*thing)();  //normal dereference
      thing();     //short form with * omitted

      return 0;
}
```

Motivation

Why would we want function pointers?

Motivation

- Consider a bubble sort that sorts an array of strings
  - The book uses quicksort as the example, but I don't want to get caught up in the confusing parts of quicksort

```
void bubbleSort(char* array[], int length)
{
      char* temp;
      int i, j;
      for(i = 0; i < length - 1; i++ )
            for(j = 0; j < length - 1; j++ )
                  if(strcmp(array[j],array[j+1]) > 0)
                  {
                        temp = array[j];
                        array[j] = array[j + 1];
                        array[j + 1] = temp;
                  }
}
```

Motivation

- Now consider a bubble sort that sorts arrays of pointers to single **`int`** values

```
void bubbleSort(int* array[], int length)
{
      int* temp;
      int i, j;
      for(i = 0; i < length - 1; i++ )
            for(j = 0; j < length - 1; j++ )
                  if(*(array[j]) > *(array[j+1]))
                  {
                        temp = array[j];
                        array[j] = array[j + 1];
                        array[j + 1] = temp;
                  }
}
```

A rectangle struct

- Let's pause for a moment in our consideration of sorts and make a struct that can contain a rectangle

```
typedef struct
{
     double x;          //x value of upper left
     double y;          //y value of upper left
     double length;
     double height;
} Rectangle;
```

Motivation

- Now consider a bubble sort that sorts arrays of pointers to **`Rectangle`** structs
  - Ascending sort by x value, tie-breaking with y value

```
void bubbleSort(Rectangle* array[], int length)
{
	Rectangle* temp;
	int i, j;
	for(i = 0; i < length - 1; i++ )
		for(j = 0; j < length - 1; j++ )
			if(array[j]->x > array[j+1]->x ||
			(array[j]->x == array[j+1]->x &&
			array[j]->y > array[j+1]->y))
			{
				temp = array[j];
				array[j] = array[j + 1];
				array[j + 1] = temp;
			}
}
```

Universal sort

- We can write a bubble sort (or ideally an efficient sort) that can sort anything
  - We just need to provide a pointer to a comparison function

```
void bubbleSort(void* array[], int length,
     int (*compare)(void*, void*))
{
     void* temp;
     int i, j;
     for( i = 0; i < length - 1; i++ )
          for(j = 0; j < length - 1; j++ )
               if(compare(array[j],array[j+1]) > 0)
               {
                    temp = array[j];
                    array[j] = array[j + 1];
                    array[j + 1] = temp;
               }
}
```

Typechecking

- Function pointers don't give you a lot of typechecking
- You might get a warning if you store a function into an incompatible pointer type
- C won't stop you
- And then you'll be passing who knows what into who knows where and getting back unpredictable things

Simulating OOP

- C doesn't have classes or objects
- It is possible to store function pointers in a struct
- If you always pass a pointer to the struct itself into the function pointer when you call it, you can simulate object-oriented behavior
- It's clunky and messy and there's always an extra argument in every function (equivalent to the **`this`** pointer)
- As it turns out, Java works in a pretty similar way
  - But it hides the ugliness from you

Upcoming

Next time…

- Introduction to C++

Reminders

- Keep working on Project 6
  - It's tough!