15-122: Principles of Imperative Computation

Recitation 13 — Josh Zimmerman, Nivedita Chopra

Everything has an address!

Well, anything you can name—all variables and functions.

We can use the address of operator, &, to find what this address is.

This is useful if we want to modify a variable in place.

Checkpoint 0

```
1  #include <stdio.h>
2  #include "contracts.h"
3
4  void bad_mult_by_2(int x) {
5     x = x * 2;
6  }
7  void mult_by_2(int* x) {
8     REQUIRES(x != NULL);
9     *x = *x * 2;
10 }
11 int main () {
12    int a = 4;
13    bad_mult_by_2(a);
14    printf("%d\n", a);
15    mult_by_2(&a);
16    printf("%d\n", a);
17    return 0;
18 }
```

What is the output when this code is run? Why?

`switch` statements

A `switch` statement is a different way of expressing a conditional. The general format of this looks like:

```
1  switch (e) {
2     case c1:
3        // do something
4        break;
5     case c2:
6        // do something else
7        break;
8     // ...
9     default:
10       // do something in the default case
11       break;
12 }
```

Each `ci` should evaluate to a constant integer type (this can be of any size, so `chars`, `ints`, `long long ints`, etc).

For example, consider this function that moves on a board. It takes direction ('l', 'r', 'u', or 'd') and prints an English description of the direction.

```c
void print_dir(char c) {
   switch (c) {
      case 'l':
         printf("Left\n");
         break;
      case 'r':
         printf("Right\n");
         break;
      case 'u':
         printf("Up\n");
         break;
      case 'd':
         printf("Down\n");
         break;
      default:
         fprintf(stderr, "Specify a valid direction!\n");
         break;
   }
}
```

The `break` statements here are important: If we don't have them, we get fall-through, which is often useful, but can lead to unanticipated results.

Here's some code that takes a positive number at most 10 and determines whether it is a perfect square. The behavior here is called fall-through.

```c
int is_perfect_square(int x) {
   REQUIRES(1 <= x && x <= 10);
   switch (x) {
      case 1:
      case 4:
      case 9:
         return 1;
         break;
      default:
         return 0;
         break;
   }
}
```

Checkpoint 1

```c
#include <stdio.h>
#include <stdlib.h>
int main(int argc, char** argv) {
   if (argc > 1) {
      int a = atoi(argv[1]);
      switch (a % 2) {
         case 0:
            printf("x is even!\n");
         default:
            printf("x is odd!\n");
      }
   }
   return 0;
}
```

What's wrong with this code? How would you fix it?

`structs` that aren't pointers

We've almost always used *pointers* to `structs` previously in this class.

We can also just use `structs`, without the pointer. We set a field of a `struct` with dot-notation, as follows:

```
1  #define ARRAY_LENGTH 10
2  struct point {
3     int x;
4     int y;
5  };
6  int main () {
7     struct point a;
8     a.x = 3;
9     a.y = 4;
10    struct point* arr = xmalloc(ARRAY_LENGTH * sizeof(struct point));
11    // Initialize the points to be on a line with slope 1
12    for (int i = 0; i < ARRAY_LENGTH; i++) {
13       arr[i].x = i;
14       arr[i].y = i;
15    }
16 }
```

The notation we've used throughout the semester to access a field of a pointer to a struct is `p->f`. This is just syntactic sugar for `(*p).f`.

Casting pointers to ints and signed to unsigned

Casting from pointers to integers and signed values to unsigned values is implementation-defined in C. (That is, C does not mandate the way that compilers should handle these details. For Lab 9, we'll use the behaviors that GCC defines.)

A few details:

The GCC documentation specifies how casting from pointers to ints works:
`http://gcc.gnu.org/onlinedocs/gcc-4.3.5/gcc/Arrays-and-pointers-implementation.html#Arrays-and-pointers-implementation`

In Lab 9 (the C0 Virtual Machine), we'll provide you with `INT(p)` and `VAL(x)` to cast between integers and pointers.

Make sure to review the lecture notes for more details on casting.

Checkpoint 2

What's wrong with each of these pieces of code?

a)

```
1 int* add_dumb(int a, int b) {
2    int x = a + b;
3    return &x;
4 }
```

b)

```
int main () {
   int* A = xcalloc(10, sizeof(int));
   for (int i = 0; i < 10 * sizeof(int); i++) {
      *(A + i) = 0;
   }
   free(A);
   return 0;
}
```

c)

```
void add_one(int a) {
   a = a + 1;
}
int main() {
   int x = 1;
   add_one(x);
   printf("%d\n", x);
   return 0;
}
```

d)

```
int main() {
   int x = 0;
   if (x = 1)
      printf("woo\n");
   return 0;
}
```

e)

```
int main() {
   char s[] = {'a', 'b', 'c'};
   printf("%s\n", s);
   return 0;
}
```

f)

```
int main () {
   char* y = "hello!";
   char* x = xmalloc(7 * sizeof(char));
   strncpy(x, y, strlen(y));
   printf("%zu\n", strlen(x));
   free(x);
   return 0;
}
```

g)

```
int foo(char* s) {
   printf("The string is %s\n", s);
   free(s);
}
int main() {
   char* s = "hello";
   foo(s);
   return 0;
}
```