Announcements

- Program #1B
  - Due Today
  - Midterm #1 is next Tuesday
- Reading
  - Chapter 6 (today)
  - Chapter 11 (next Tuesday)

Pointers

- Can declare any variable to be of type pointer
  - are similar to references in Java
  - use * before variable name to create a pointer to the type
    - int *foo;
    - myTypeDef *myPtr;
    - float *bar;
  - The type determines both:
    - what is pointed to
    - the size of the object being pointed to
- Initialization
  - creating a pointer doesn't create the space it points to
  - int *foo;
  - *foo = 3; /* error: haven't defined what it points to */

Type Conversion

- **C lets you assign variables of different types**
  - called type conversion
  - useful when dealing with
    - external devices
      - int *fooDev = (int *) 100;
      - we know the foo device is at location 100
    - when type information read from a file is based on file contents.
- **WARNING: This can be very dangerous**
- (type *) variable:
  - int *x;
  - float *y;
  - x = (int *) y;

Other Pointer Declarations

- Can declare a pointer to a pointer
  - int **p; /* p pointer to a variable that points to an int */
  - useful if you want to modify a pointer in a subroutine
- What declaration:
  - int *p, q;
  - declares p as a pointer to an integer and q as an integer
- Typedefs of pointers improve readability
  - typdef int *intPtr;
  - intPtr p, q;

Pointer Assignments

- Pointers a normal variables
  - they are not initialized unless assigned
- Sample Assignments:
  - int *p, *q, i1, i2;
  - p = &i1; /* p now points to i1 */
  - q = p; /* q now points to i1 too */
  - p = &i2; /* p now points to i2 */
  - *p = *q; /* the value of i1 is copied to i2 */

Generic Pointers

- void *
  - Declare a pointer that can point to any type
  - Any use are assignment requires a cast:
    - void *p;
    - int *x;
    - int *y;
    - p = (void *) x;
    - y = (int *) p;
  - Allows writing generic code
    - Need to ensure only appropriate things happen:
      - int *x;
      - float *y;
      - void *p;
      - p = (void *) x;
      - y = (float *) p;

NULL Pointer

- NULL is a pointer to nothing
  - (void *) 0 is its type
  - defined in stdlib.h
- Can be used to initialize pointers
  - int *p;
  - p = NULL;
- Can be used in comparison
  - if (p != NULL) {
    ….
  - }
- Often returned by functions to indicate error

Pointer Examples

```
size_t strlen(char *str)
{
    size_t length;

    for (length=0; *str != '\0'; str++) {
        length++;
    }
}
```

Array of Strings Example

```
int findIt(char **table, char *it)
{
    int count = 0;

    while (*table) {
        if (!strcmp(*table, it)) {
            return count;
        }
        table++;
    }
    return -1;
}
```

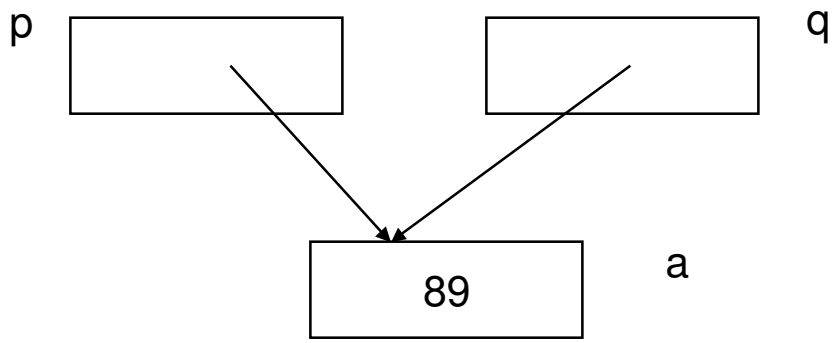
Const Keyword and Pointers

- const int *p;
  - pointer to an integer that doesn't change:
  - const x = 42;
  - p = &x; /* legal */
  - *p = 20; /* illegal - changing the constant */
- int *const p;
  - constant pointer to an integer;
  - int *const p = &foo;
  - *p = 42; /* ok: just changing the value */
  - p = &bar; /* illegal: changing the pointer */

Pointer Aliases

- Sometimes two pointers point to the same thing
  - This can be useful
  - This can cause problems:

```
int *p, *q;
int a= 89;
p = &a;
q = p;
free(p);
if (*q) { … }        /* error: *q points to freed space */
```



Other Pointer Operations

- Subtraction
  - pointer and int
    - p - n a pointer to the nth element before p
  - pointer and pointer
    - p - q number of items between p and q
- Relational operations:
  - <, <=, >, >=, ==, !=
    - all compare two pointers of the same type
    - compares the memory location pointed to

Pointers and Functions

- Parameters
  - can use const to prevent functions from changing values

```
int frob(const char *data, int size) {
    if (data[0] == 'Q') { .. }     /* OK: just using the data */
    data[2] = 42                   /* Error: can't modify data */
}
```

- Functions can return pointer types

```
int *getStuff(int *a, *b) {
   if (*a > *b ) {
      return a;
   } else {
      return b;
   }
}
```

Dangling Reference

- Problem: Stack variables go out of scope on return
- Consider:

```
int *foo() {
        int x = 42;
    return (&x);
}
```