Today’s lecture

- Strings
- String I/O.
- String Comparison.

Strings

A string is any 1-dimensional character array that is terminated by a null character.

- Null is ‘\0’.
- For local use, we declare strings by char *s = "thestring" or char s[11]
- char *s = "thestring" declares a pointer variable that points to the first character of the (constant) string;
- Strings are declared in function arguments either as char *s or char s[].
  
  eg, void foo(char *s) or void foo(char s[])
  
  (meaning ... a pointer to a char)
- In declaring a string, array length must be 1 greater than the longest string it will hold, to allow for the null.
char * and char[]

char *a makes space for a single pointer variable – it makes no space for the string.
char b[] makes space for the string (but makes no space for a pointer).

If you want a string to read into or modify, use char[].
char b[] = "I can be written into";
char c[256]; // a nice big string to use

If you want a constant string (e.g. for messages), you can use char *.
char *a = "I can’t be written into";

If you want a variable to refer to strings that already exist, use char *.
char *a;

See end of lecture for gory details.

The string library

▶ Need to include it at the start:
  ◀ #include <string.h>
▶ To copy a string s2 into s1:
  ◀ strcpy(s1,s2);  strcat(s1,"Hello\n");
▶ To add s2 onto the end of s1:
  ◀ strcat(s1,s2)
▶ Returns the length of s1:
  ◀ strlen(s1)
▶ Many others . . .

String I/O

(don't need <string.h> for these)
▶ To printf a string: printf("%s", s1);
▶ To read in a string:
  ◀ scanf("%s", s1);  /* ?why no & on s1? */

Write/Read from a string (not I/O stream):
▶ To print a float a into a string s1:
  ◀ snprintf(s1,"hello, num=%f", a);
  ◀ snprintf returns an integer, being the number of chars written;
  ◀ make sure s1 has space.
▶ Similarly, we can read ints/floats etc; from a string via sscanf:
  ◀ int sscanf(s1, "%d Montgomery St", &door);
  ◀ Value returned is the number of variables assigned to.
What about <, <=, == etc on strings?

```c
int main(void) {
    char sone[] = "hiya";
    char stwo[] = "cp";
    char sthr[] = "coders";
    if (sone <= stwo) {
        printf(""hiya" is less than or equal to "cp".\n");
    } else {
        printf(""cp" is less than "hiya".\n");
    }
    if (stwo <= sthr) {
        printf(""cp" is less than or equal to "coders".\n");
    } else {
        printf(""coders" is less than "cp".\n");
    }
    return EXIT_SUCCESS;
}
```

Comparing arrays of other types

A string is a char array. What about comparing arrays of ints or floats?

```c
int memcmp (const void *a1, const void *a2, size_t size);
```

- `memcmp` compares the size bytes of memory beginning at `a1` against the size bytes of memory beginning at `a2`.
- Value returned has the same sign as the difference between the first differing pair of bytes.
- For this reason, only useful for testing equality, not relative order.

What is this `void *` type? `void` is a type that nothing can be! But `void *` is used as a generic pointer type: a `void *` can be cast to any other pointer type.
strncpy and friends

The requirement to ensure that s1 has enough space in strcpy(s1,s2) etc. is tedious – have to check length of s2. Frequent cause of ‘buffer overflows’ and security exposures.

For safety, all professionally written C code uses:

```c
char *strncpy(char *dest, const char *src, size_t n);
```

which copies at most n characters of src. Example:

```c
/* 50 character strings (excl. null) */
#define LEN 50
char s[LEN+1]; /* add one for the null */
strncpy(s,maybe_long_string,LEN);  /* make sure there's a null at the end */
```

Similarly for `strncat`, `snprintf` and so on.

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char * and char[]

What’s the difference between

```c
char *a = "foo1";
char b[] = "foo2";
```

a is a variable, holding a pointer to the first character of "foo1".
You can assign to it: `a = "bar";`

b is a pointer to the first character of "foo2".
You can’t assign to it. `b = "bar";` is a compile-time error.

Can you modify the contents of the string?

```c
strcpy(b,"bar"); is ok, because b is an array of characters.
strcpy(a,"bar"); fails at run-time, because a is a pointer to (the first character of) the literal string "foo1", and (reasonably enough) you can’t change a literal string!
(But a = b; strcpy(a,"bar"); is fine.)
```

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Assigned Reading (Kelley and Pohl)

For Strings: §6.10, §6.11, Appendix A.14