EECS 22: Advanced C Programming

Lecture 25

Rainer Dömer

doemer@uci.edu

The Henry Samueli School of Engineering
Electrical Engineering and Computer Science
University of California, Irvine

Lecture 25: Overview

- Course Administration
  - Reminder: Final course evaluation
- String Operations
  - Using pointers
- Standard C Library
  - Functions provided in **`string.h`**, **`stdlib.h`**
- Math Library
  - Functions provided in **`math.h`**

Course Administration

- Final Course Evaluation
  - Open until end of 10th week (Sunday night)
  - Nov. 14, 2016, through Dec. 4, 2016, 11:45pm
  - Online via EEE Evaluation application
- Mandatory Evaluation of Course and Instructor
  - Voluntary
  - Anonymous
  - Very valuable
- Please spend 5 minutes for this survey!
  - Your feedback is appreciated!

String Operations

- String Operations using Pointers
  - Example: String length

```
int Length(char *s)
{
   int l = 0;
   char *p = s;

   while(*p != 0)
   { p++;
     l++;
   }
   return l;
}
```

```
char s1[] = "ABC";
char s2[] = "Hello World!";

printf("Length of %s is %d\n",
            s1, Length(&s1[0]));
printf("Length of %s is %d\n",
            s2, Length(&s2[0]));
```

```
Length of ABC is 3
Length of Hello World! is 12
```

String Operations

- String Operations using Pointers
  - Example: String length

```
int Length(char *s)
{
   int l = 0;
   char *p = s;

   while(*p != 0)
   { p++;
     l++;
   }
   return l;
}
```

```
char s1[] = "ABC";
char s2[] = "Hello World!";

printf("Length of %s is %d\n",
            s1, Length(&s1[0]));
printf("Length of %s is %d\n",
            s2, Length(s2));
```

```
Length of ABC is 3
Length of Hello World! is 12
```

  - Array and pointer types are equivalent
    - **s2** is an array, but can be passed as a pointer argument
    - Character array **s2** is same as character pointer **&s2[0]**

String Operations

- String Operations using Pointers
  - Example: String length

```
int Length(char *s)
{
   int l = 0;
   char *p = s;

   while(*p != 0)
   { p++;
     l++;
   }
   return l;
}
```

```
char s1[] = "ABC";
char *s2  = "Hello World!";

printf("Length of %s is %d\n",
            s1, Length(s1));
printf("Length of %s is %d\n",
            s2, Length(s2));
```

```
Length of ABC is 3
Length of Hello World! is 12
```

  - Array and pointer types are equivalent
    - **s1** is an array of characters, **s2** is a pointer to character
    - Both **s1** and **s2** can be passed to character pointer **s**

String Operations

- String Operations using Pointers
  - Example: String length

```
int Length(char s[])
{
   int l = 0;
   char *p = s;

   while(*p != 0)
   { p++;
     l++;
   }
   return l;
}
```

```
char s1[] = "ABC";
char *s2  = "Hello World!";

printf("Length of %s is %d\n",
            s1, Length(s1));
printf("Length of %s is %d\n",
            s2, Length(s2));
```

```
Length of ABC is 3
Length of Hello World! is 12
```

  - Array and pointer types are equivalent
    - **s1** is an array of characters, **s2** is a pointer to character
    - Both **s1** and **s2** can be passed to character array **s**

String Operations

- String Operations using Pointers
  - Example: String copy

```
void Copy(
     char *Dst,
     char *Src)
{
 do{
     *Dst = *Src;
     Dst++;
   } while(*Src++);
}
```

```
char s1[] = "ABC";
char s2[] = "Hello World!";

printf("s1 is %s, s2 is %s\n",
                s1, s2);
Copy(s2, s1);
printf("s1 is %s, s2 is %s\n",
                s1, s2);
```

```
s1 is ABC, s2 is Hello World!
s1 is ABC, s2 is ABC
```

  - Passing pointers as arguments to functions
    - Function can modify caller data by pointer dereferencing
    - Passing pointers = Pass by reference!

String Operations

- String Operations using Pointers
  - Example: String copy

```
void Copy(
     char *Dst,
    const char *Src)
{
 do{
     *Dst = *Src;
     Dst++;
   } while(*Src++);
}
```

```
char s1[] = "ABC";
char s2[] = "Hello World!";

printf("s1 is %s, s2 is %s\n",
               s1, s2);
Copy(s2, s1);
printf("s1 is %s, s2 is %s\n",
               s1, s2);
```

```
s1 is ABC, s2 is Hello World!
s1 is ABC, s2 is ABC
```

  - Passing pointers as arguments to functions
    - Function can modify caller data by pointer dereferencing
    - Type qualifier **const**:
      Modification by pointer dereferencing *not* allowed!

String Operations

- String Operations using Pointers
  - Example: String copy

```
void Copy(
    const char *Dst,
    const char *Src)
{
 do{
     *Dst = *Src;
     Dst++;
   } while(*Src++);
```

Error!
Write access to **const** data!

```
char s1[] = "ABC";
char s2[] = "Hello World!";

printf("s1 is %s, s2 is %s\n",
               s1, s2);
Copy(s2, s1);
printf("s1 is %s, s2 is %s\n",
               s1, s2);
```

```
s1 is ABC, s2 is Hello World!
s1 is ABC, s2 is ABC
```

  - Passing pointers as arguments to functions
    - Function can modify caller data by pointer dereferencing
    - Type qualifier **const**:
      Modification by pointer dereferencing *not* allowed!

Standard Library

- Standard C library
  - standard library supplied with every C compiler
  - predefined standard functions
    - e.g. **`printf()`**, **`scanf()`**, etc.
- C library header files
  - input/output function declarations **`#include <stdio.h>`**
  - standard function declarations **`#include <stdlib.h>`**
  - string function declarations **`#include <string.h>`**
  - others
- C library linker file
  - contains standard function definitions (pre-compiled)
    - library file **`libc.a`**
  - compiler links against the standard library by default (no need to supply extra options)

Standard Library

- Functions declared in **`string.h`** (part 1/2)
  - **`typedef unsigned int size_t;`**
    - type definition for length of strings
  - **`size_t strlen(const char *s);`**
    - returns the length of string **`s`**
  - **`int strcmp(const char *s1, const char *s2);`**
    - alphabetically compares string **`s1`** with string **`s2`**
    - returns -1 / 0 / 1 for less-than / equal-to / greater-than
  - **`int strncmp(const char *s1, const char *s2, size_t n);`**
    - same as previous, but compares maximal **`n`** characters
  - **`int strcasecmp(const char *s1, const char *s2);`**
  - **`int strncasecmp(const char *s1, const char *s2, size_t n);`**
    - same as string comparisons above, but case-insensitive

Standard Library

- Functions declared in **`string.h`** (part 2/2)
  - **`char *strcpy(char *s1, const char *s2);`**
    - copies string **`s2`** into string **`s1`**
  - **`char *strncpy(char *s1, const char *s2, size_t n);`**
    - copies maximal **`n`** characters of string **`s2`** into string **`s1`**
  - **`char *strcat(char *s1, const char *s2);`**
    - concatenates string **`s2`** to string **`s1`**
  - **`char *strncat(char *s1, const char *s2, size_t n);`**
    - concatenates maximal **`n`** characters of string **`s2`** to string **`s1`**
  - **`char *strchr(const char *s, int c);`**
    - returns a pointer to the first character **`c`** in string **`s`**, or **`NULL`** if not found
  - **`char *strrchr(const char *s, int c);`**
    - returns a pointer to the last character **`c`** in string **`s`**, or **`NULL`** if not found
  - **`char *strstr(const char *s1, const char *s2);`**
    - returns a pointer to the first appearance of **`s2`** in string **`s1`** (or **`NULL`**)

Standard Library

- Functions declared in **`stdlib.h`** (selected subset)
  - **`int abs(int x);`**
  - **`long int labs(long int x);`**
    - return the absolute value of a (long) integer **`x`**
  - **`int rand(void);`**
    - return a random value in the range **`0 – RAND_MAX`**
    - **`RAND_MAX`** is a constant integer (e.g. 32767)
  - **`void srand(unsigned int seed);`**
    - initialize the random number generator with value **`seed`**
  - **`void exit(int result);`**
    - exit the program with return value **`result`**
  - **`void abort(void);`**
    - abort the program (with an error result)

Standard Library

- Standard Math Library
  - standard library supplied with every C compiler
  - predefined mathematical functions
    - e.g. *cos(x)*, *sqrt(x)*, etc.
- Math library header file
  - contains math function declarations
  - **`#include <math.h>`**
- Math library linker file
  - contains math function definitions (pre-compiled)
    - library file **`libm.a`**
  - compiler needs to link against the math library
  - use option **`-l`*`libraryname`***
  - Example: **`gcc MathProgram.c -o MathProgram -lm`**

Standard Library

- Functions declared in **`math.h`** (part 1/2)
  - **`double sqrt(double x);`** $\sqrt{x}$
  - **`double pow(double x, double y);`** x^y
  - **`double exp(double x);`** e^x
  - **`double log(double x);`** $log(x)$
  - **`double log10(double x);`** $log_{10}(x)$
  - **`double ceil(double x);`** $\lceil x \rceil$
  - **`double floor(double x);`** $\lfloor x \rfloor$
  - **`double fabs(double x);`** $|x|$
  - **`double fmod(double x, double y);`** $x \bmod y$

Standard Library

- Functions declared in **`math.h`** (part 2/2)
  - **`double cos(double x);`** *cos(x)*
  - **`double sin(double x);`** *sin(x)*
  - **`double tan(double x);`** *tan(x)*
  - **`double acos(double x);`** *acos(x)*
  - **`double asin(double x);`** *asin(x)*
  - **`double atan(double x);`** *atan(x)*
  - **`double cosh(double x);`** *cosh(x)*
  - **`double sinh(double x);`** *sinh(x)*
  - **`double tanh(double x);`** *tanh(x)*