CS 537 Discussion

25 January, 2023

Agenda

1. Review/ask questions about lecture material
2. Introduction to C programming
3. Project-1 discussion

Why C?

Operating systems, drivers, embedded, high-performance computing.

Examples: Linux kernel, Python, PHP, Perl, C#, Google search engine/Chrome/MapReduce/etc, Firefox

Issues with C

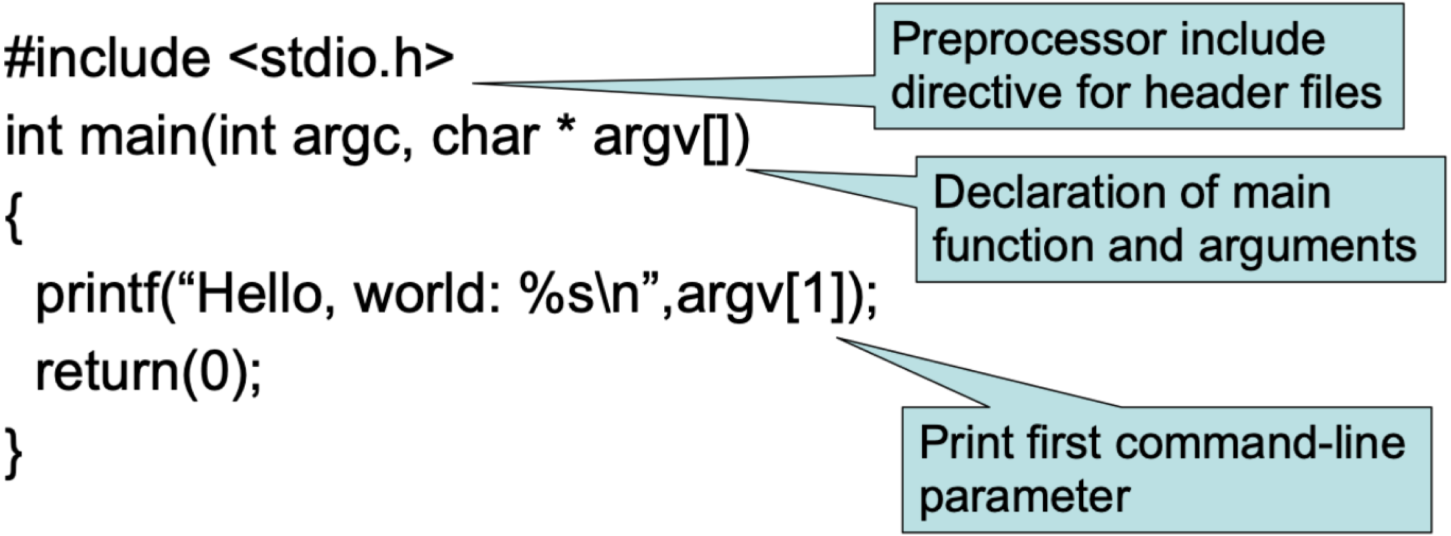
Little hand-holding for programmers

- Manual memory management
- Small standard library
- No native support for threads and concurrency
- Weak type checking

Builtin Types in C

Type	Size	Comment
char	1	ASCII character
int	4	Integer
long int	8	Longer Integer
float	4	Decimal number
double	8	Decimal number
long double	16	Even Longer decimal

C language



```
#include <stdio.h>
int main(int argc, char * argv[])
{
  printf(“Hello, world: %s\n”,argv[1]);
  return(0);
}
```

Preprocessor include directive for header files

Declaration of main function and arguments

Print first command-line parameter

Compiling C code

```
$ gcc hello-world.c
```

Compiling C code

```
$ gcc hello-world.c -Wall -Werror -O3 -g
```

1. -Wall: enables all the warnings about constructions that some users consider questionable, and that are easy to avoid
2. -Werror: Make all warnings into errors.
3. -O[x]:
   a. 0-3: optimization level with 0 being the lowest and 3 being the highest.
   b. s: optimize for binary size
   c. fast: all O3 optimization + some other unsafe optimizations
   d. g: optimize for debugging
4. -g: include debug info in the binary.

Strings

- Strings in C are arrays of bytes.
    - char str[100]
- They are null terminated - so you need to make space for it.
    - str[0] = ‘\0’
    - strlen(str) = 0
- There are a bunch of functions to work with them:
    - strlen, strcpy, strcat

Memory

- You have to manage memory by yourself.
- Fixed-size variables can be allocated on a stack
  - The contents of these variables go away when the function returns:

    ```
    char str[100] = “hello, world\n”;
    ```

- Variable-size variables are allocated using **malloc** similar to new() in Java,
  - Memory from malloc only becomes invalid when you free it.

    ```
    char  *str;

    str = malloc(n);

    strcpy(str, “hello, world\n”);

    free(str)
    ```

File I/O

- Functions for accessing files:
    - struct FILE : represents an open file
    - FILE *f: declares a file pointer to handle and keep track on files being accessed
    - f = fopen(“foo”, “r”): opens file foo for reading
    - fclose(f): closes the file once done with f
    - fgets(buffer, n, f): reads n bytes from f into buffer
    - fputs(buffer, f): writes n bytes to f from buffer
    - fread(buffer, size, count, f): reads size x count bytes from f into buffer
    - fwrite(buffer, size count, f): writes size x count bytes to f from buffer

How to debug your programs

- Add print statements
  - Print things out all the time to see what is happening
  - Problem: this is hard for large input files
- Use a **debugger**
  - Allows you to stop your program while it is executing and see the contents of the all the your variables
    - You can say where to stop by adding breakpoints
  - GUI debuggers: Visual Studio
    - Shows lots of stuff in windows
  - Command line debuggers: gdb
    - You can enter command to see everything

Debugging using gdb

- Compile with debugging using “-g”: gcc -g hello.c
- Run the program with gdb

```
$ gdb  ./a.out
```

Project-1

Objective:

- Re-familiarize yourself with the C programming language
- Familiarize yourself with a shell / terminal / command-line of UNIX
- Learn about how UNIX command line utilities are implemented

Project-1 overview

- Create a fortune telling utility
- while(!Done)
  - read fortune database (which is basically a text file)
  - parse fortune database
  - handle all the error messages
  - outputs fortune based on number or batch mode
- Assignment is up, and is due in on Feb 1st by 11:59pm

Project Demo

CSL machine

Login to CSL machine:

1. Connect to VPN
2. ssh <cs-login>@best-linux.cs.wisc.edu

Project submission

- Copy your files to ~cs537-1/handin/login/P1.

  Example: cp badger_fortune.c ~cs537-1/handin/anjali5/P1/

- Files to submit:
  - One .c file: badger_fortune.c, compile successfully with -Wall and -Werror flags.
  - Add a README.md describing your implementation.

What does this C code do?

```
int minval(int A[], int n) {
 int cmin;
 for (int i=0; i<n; i++)
   if (A[i] < cmin)
     cmin = A[i];
 return cmin;
}
```

Find the issue

```
if (x = 0)

  y == 7; // assign y as 7 if x was 0

/****************************************************************************************************/

int A[10];

int sum = 0;

for (int i = 0; i <= 10; i++) sum += A[i]; // sum of array `A`

/****************************************************************************************************/
```