

CSCB09 Software Tools and Systems Programming

C – I/O

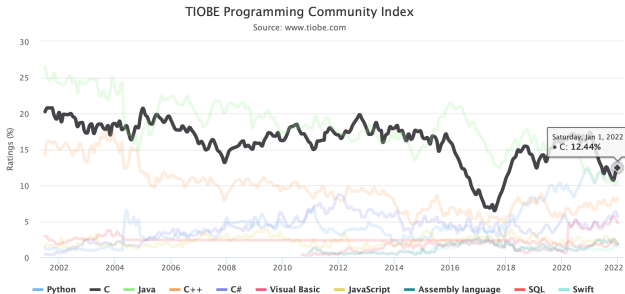
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C Programming Language

- Widely used and important.
- Impressive for a language that was invented in 1972!
- We will use the standard c99.
- Used in a huge range of disciplines, from OS, controllers, upto applications in scientific disciplines.



<https://www.tiobe.com/tiobe-index/>

Why C?

- What do you think about C so far ...?
- Disappointed about the lack of support for strings, arrays, etc.... ?
- Turns out you also have to do much of memory management manually

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Your ride with Python

- Cruise control
- Seat heating
- Cup holders

Your ride with C

- Performance and speed
- But... no amenities... (!)
- and it only comes with a stickshift...
- ...

I/O

I/O between User and Program

- From A48, output to terminal (STDOUT): `printf()`
- STDOUT, STDERR, STDIN
- What about input from keyboard?
 - Command line input
 - STDIN input

Exercise 1

- Implement a simplified version of the `wc` (word count) utility with only one functionality:
- Your program will use `scanf` to count the number of words (strings) the user inputs and print the count to the screen.
- The user signals the end of input (EOF = End of File) by hitting Ctrl-D (Ctrl-Z on Windows) on a new line
- (For simplicity you may assume no input word is longer than 20 characters)

```
#include <stdio.h>

int main() {

    // YOUR CODE HERE !!!

}
```

Exercise 1 – solution

```
1 #include <stdio.h>
2
3 int main(){
4     char input_string[20];
5     int counter = 0;
6
7     while (scanf("%s", input_string) != EOF) {
8         counter = counter + 1;
9     }
10
11     printf("%d\n", counter);
12 }
```


CLA: Command Line Arguments

Command Line Arguments

```
int main(int argc, char **argv)
```

- What is: `char **argv` ?

Quick review of string and array facts

- What is a string?
 - Array of chars
 - Null character ('\\0') denotes the string end
 - C library functions to operate on strings, <string.h>

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// NOT: name = "CSCB09";
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- How would you declare an array of 30 strings?

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name_list[0] = name;
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Command Line Arguments

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Command Line Arguments

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```

- What is: `char **argv` ?
- An array of strings
- Need `argc` to know how many strings to expect in array.
- `argv[1]` is the first command line argument
- and so, what is `argv[0]` then?

Adding CLAs to wc...

- Extend your word count program to take exactly one command line argument.
- If the commandline argument is “-w” your program will print the number of words in user input (as before)
- If the commandline argument is “-c” your program will print the number of characters in user input
- As before, the user signals the end of input (EOF = End of File) by hitting Ctrl-D (Ctrl-Z on Windows) on a new line
- (For simplicity you may assume that the user does provide exactly one command line argument).

Exercise 2 – solution

```
#include <stdio.h> // basic I/O, eg. printf
#include <string.h> // for strings manipulation

int main(int argc, char **argv) {

    char input_string[20];
    char input_c;
    int counter = 0;

    // CLA processing: -w _ words
    if (strcmp(argv[1], "-w") == 0) {
        while (scanf("%s", input_string) != EOF) {
            counter = counter + 1; // increment counter
        }
        printf("%d\n", counter);
        return 0;
    }
}
```

```

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2 #include <string.h> // for strings manipulation
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4 int main(int argc, char **argv) {
5
6     char input_string[20];
7     char input_c;
8     int counter = 0;
9
10    // CLA processing: -w _ words
11    if (strcmp(argv[1], "-w") == 0) {
12        while (scanf("%s", input_string) != EOF) {
13            counter = counter + 1; // increment counter
14        }
15        printf("%d_\n", counter);
16        return 0;
17    }
18
19    // CLA processing: -c _ characters
20    if (strcmp(argv[1], "-c") == 0) {
21        while (scanf("%c", &input_c) != EOF) {
22            counter = counter + 1; // increment counter
23        }
24        printf("%d_\n", counter);
25        return 0;
26    }
27
28    printf("Invalid argument!");
29 }

```

1. In real program:
check that argc==2
2. In real program: read
at most 20 chars
scanf("%20s", ...)
3. Improvements: ...

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```

- For general file I/O need to specify where to read to / write from:

```
int fprintf(FILE *stream, const char *format, ...)
int fscanf(FILE *stream, const char *format, ...)
```

File interfaces in C/Unix

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 - Each open file is identified by a small integer
 - STDIN is 0, STDOUT is 1
 - Use for pipes, sockets (will see later what those are ...)
 - (Remember how I said in first lecture that everything is a file ..?)

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- File *descriptors* (low-level, managed by OS):
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 - STDIN is 0, STDOUT is 1
 - Use for pipes, sockets (will see later what those are ...)
 - (Remember how I said in first lecture that everything is a file ..?)
- File *pointers* (aka streams, file handles) for regular files:
 - A C language construct for easier working with file descriptors
 - You use a pointer to a file structure (FILE *) as handle to a file.
 - The file struct contains a file descriptor and a buffer.
 - Use for regular files

Operating on regular files

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Operating on regular files

- Let's say we want to read from/write to a file `my_file.txt`
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- A file first needs to be opened to obtain a `FILE *`

```
FILE *fopen(const char *filename, const char *mode)
```

- `filename` identifies the file to open
- `mode` tells how to open the file:
 - "r" for reading, "w" for writing, "a" for appending
- returns a pointer to a `FILE` struct which is the handle to the file.
- To close a file: `void fclose(FILE *stream);`

```
FILE *fp = fopen("my_file.txt", "w");  
fprintf(fp, "Hello!\n");  
fclose(fp);
```

Exercise 3

- Extend our Exercise 1 word count program to take exactly one command line argument, which is a file name.
- This program will open the file, count the number of words in it and print the count.

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```

```
FILE *fopen(const char *path, const char *mode);
int fscanf(FILE *stream, const char *format, ...);
int fclose(FILE *stream);
```

Exercise 3 – solution

```
#include <stdio.h>

int main(int argc, char **argv){
    char input_string[20];
    int wc = 0;
    FILE *input_file;

    input_file = fopen(argv[1], "r");
    // In real programs, error check after opening file:
    // if (input_file == NULL) then there was an error
    while( fscanf(input_file, "%s", input_string) != EOF) {
        wc = wc + 1;
    }

    fclose(input_file);
    printf("%d\n", wc);
}
```

Basic file I/O functions (stdio.h)

```
FILE *fopen(const char *path, const char *mode);  
int fscanf(FILE *stream, const char *format,...);  
char *fgets(char *s, int size, FILE *stream);  
char fgetc(FILE *stream);  
int fprintf(FILE *stream, const char *format,...)  
int fputs(const char *str, FILE *stream);  
int fseek(FILE *stream, long int offset, int whence);  
void rewind(FILE *stream);  
int fclose(FILE *stream);
```