

# C Programming

A crash course for C++ programmers

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## C vs. C++: Differences

- C does not have classes/objects!
  - all code is in functions (subroutines).
- C structures can not have methods
- C I/O is based on library functions:
  - printf, scanf, fopen, fclose, fread, fwrite, ...

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## C vs. C++: Differences (cont.)

- C does not support any function overloading (you can't have 2 functions with the same name).
- C does not have `new` or `delete`, you use `malloc()` and `free()` library functions to handle dynamic memory allocation/deallocation.
- C does not have *reference variables*

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## C vs. C++: Similarities

- Built-in data types: `int`, `double`, `char`, etc.
- Preprocessor (handles `#include`, `#define`, etc.)
- Control structures: `if`, `while`, `do`, `for`, etc.
- Operators: `+` `-` `*` `/` `=` `==` `!=` `<` `>` `+=` `++` etc.

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## C vs. C++: Similarities (cont.)

- There must be a function named `main()`.
- function definitions are done the same way.
- Can split code in to files (object modules) and link modules together.

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## Simple C Program

```
#include <stdio.h>

int main(void) {
    printf("Hello World\n");
    return(0);
}
```

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## Another Program

```
#include <stdio.h>

void printhello(int n) {
    int i;
    for (i=0;i<n;i++)
        printf("Hello World\n");
}

void main() {
    printhello(5);
}
```

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## Typical C Program

includes →

defines, data type definitions, global variable declarations →

function definitions →

main() →

```
#include <stdio.h>
#include <stdlib.h>
#define MAX 1000
typedef char bigstring[MAX];
char *reverse(char *s) {
    char buf[MAX];
    int len;
    len = strlen(s);
    printf("reversing %s\n",s);
    for (i=len-1;i>=0;i--)
        buf[i] = s[len-1-i];
    strcpy(buf,s);
    return(buf);
}

void main(int argc,char **argv) {
    if (argc<2) {
        printf("invalid usage - must supply a string\n");
        exit(1);
    }
    printf("%s\n",reverse(argv[1]));
}
```

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## A Real C Program

- Program that accepts one command line argument.
- Treats the command line argument as a string, and reverses the letters in the string.
- Prints out the result (the reversed string).

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## reverse.c - part 1

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```
#include <stdio.h> /* printf */
#include <stdlib.h> /* malloc,free */

/* MAX is the size of the largest string
we can handle */
#define MAX 1000

/* bigstring is a new data type */
typedef char bigstring[MAX];
```

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## reverse.c - part 2

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```
/* reverses a string in place
returns a pointer to the string
*/
char *reverse( char *s) {
    bigstring buf;
    int i,len;
    len = strlen(s); /* find the length */
    for (i=0;i<len;i++)
        buf[i] = s[len-i-1];
    buf[i]='\0'; /* null terminate!*/
    strcpy(s,buf); /* put back in to s */
    return(s);
}
```

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## reverse.c - part 3

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```
void main(int argc,char **argv) {
    if (argc<2) {
        printf("Invalid usage - must supply
a string\n");
        exit(0);
    }
    printf("%s\n",reverse(argv[1]));
}
```

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## Using dynamic allocation

```
char *reverse( char *s) {
    char *buf;
    int i,len;
    len = strlen(s);

    /* allocate memory */
    buf = malloc(len+1);

    for (i=0;i<len;i++)
        buf[i] = s[len-i-1];
    buf[i]='\0';
    strcpy(s,buf); free(buf);
    return(s);
}
```

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## Compiling on Unix

Traditionally the name of the C compiler that comes with Unix is “cc”.

We can use the Gnu compiler named “gcc”.

```
gcc -o reverse reverse.c
```

tells the compiler to  
create executable file  
with the name **reverse**

tells the compiler  
the name of the input  
file.

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## Running the program

```
>./reverse hidave
evadih
```

```
>./reverse This is a long string
sihT
```

```
>./reverse "This is a long string"
gnirts gnol a si sihT
```

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## C Libraries

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- Standard I/O: printf, scanf, fopen, fread, ...
- String functions: strcpy, strspn, strtok, ...
- Math: sin, cos, sqrt, exp, abs, pow, log, ...
- System Calls: fork, exec, signal, kill, ...

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## Quick I/O Primer - printf

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```
int printf( const char *, . . . );
```

. . . means “variable number of arguments”.  
The first argument is required (a string).

Given a simple string, printf just prints the  
string (to *standard output*).

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## Simple printf

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```
printf("Hi Dave - I am a string\n");
```

```
printf("I\thave\ttabs\n");
```

```
char s[100];  
strcpy(s, "printf is fun!\n");  
printf(s);
```

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## arguing with printf

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You can tell `printf` to embed some values in the string – these values are determined at run-time.

```
printf("here is an integer: %d\n",i);
```

the `%d` is replaced by the value of the argument following the string (in this case `i`).

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## More integer arguments

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```
printf("%d + %d = %d\n",x,y,x+y);
```

```
for (j=99;j>=0;j--)  
    printf("%d bottles of beer on the wall\n");
```

```
printf("%d is my favorite number\n",17);
```

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## printf is dumb

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- `%d` is replaced by the value of the parameter when treated as a integer.
- If you give `printf` something that is not an integer – it doesn't know!

```
printf("Print an int %d\n","Hi Dave");
```

```
Print an int 134513884
```

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## Other formats

- `%d` is a format – it means “treat the parameter as a signed integer”
- `%u` means unsigned integer
- `%x` means print as hexadecimal
- `%s` means “treat it as a string”
- `%c` is for characters (`char`)
- `%f` is for floating point numbers
- `%%` means print a single `'%'`

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## Fun with printf

```
char *s = "Hi Dave";  
printf("The string \"%s\" is %d  
characters long\n",  
       s, strlen(s));  
  
printf("The square root of 10 is  
%f\n", sqrt(10));
```

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## Controlling the output

- There are formatting options that you can use to control field width, precision, etc.

```
printf("The square root of 10 is  
%20.15f\n", sqrt(10));
```

```
The square root of 10 is  
3.162277660168380
```

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## Lining things up

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```
int i;
for (i=1;i<5;i++)
    printf("%2d %f %20.15f\n",
           i,sqrt(i),sqrt(i));
```

1	1.000000	1.0000000000000000
2	1.414214	1.414213562373095
3	1.732051	1.732050807568877
4	2.000000	2.0000000000000000

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## Alas, we must move on

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- There are more formats and format options for `printf`.
- The *man page* for `printf` includes a complete description (any decent C book will also).
- NOTE: to view the man page for `printf` you should type the following: `man 3 printf`

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## Input - scanf

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- `scanf` provides input from *standard input*.
- `scanf` is every bit as fun as `printf`!
- `scanf` is a little scary, you need to use pointers  
*Please NOOOOOOOOOOOOOOOOO*  
*Not Pointers!*
- Actually, you don't really need pointers, just addresses.

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## Remember Memory?

- Every C variable is stored in memory.
- Every memory location has an *address*.
- In C you can use variables called *pointers* to refer to variables by their address in memory.

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## scanf

```
int scanf(const char *format, ...);
```

- Remember . . . means “variable number of arguments” (good thing you have a memory).
- Looks kinda like `printf`

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## What scanf does

- Uses format string to determine what kind of variable(s) it should read.
- The arguments are the *addresses* of the variables.

```
scanf("%d %d",&x,&y);
```

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## A simple example of scanf

```
float x;  
  
printf("Enter a number\n");  
scanf("%f",&x);  
  
printf("The square root of %f is  
%f\n",x,sqrt(x));
```

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## scanf and strings

Using `%s` in a `scanf` string tells `scanf` to read the next *word* from input – NOT a line of input:

```
char s[100];  
printf("Type in your name\n");  
scanf("%s",&s);  
printf("Your name is %s\n",s);
```

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## man scanf

- Check out the man page for more details.

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## Reading a line

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- You can use the function `fgets` to read an entire line:

```
char *fgets(char *s, int size,  
            FILE *stream);
```

`size` is the maximum # chars

`FILE` is a *file handle*

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## Using `fgets` to read from `stdin`

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```
char s[101];
```

```
printf("Type in your name\n");
```

```
fgets(s,100,stdin);
```

```
printf("Your name is %s\n",s);
```

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## Other I/O stuff

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- `fopen, fclose`
- `fscanf, fprintf, fgets`
- `fread, fwrite`
- Check the man pages for the details.

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## String functions

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```
char *strcpy(char *dest,  
             const char *src);  
  
size_t strlen(const char *s);  
  
char *strtok(char *s,  
             const char *delim);
```

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## Math library

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- The math library is often provided as an external library (not as part of the *standard C library*).
- You must tell the compiler you want the math library:

```
gcc -o myprog myprog.c -lm  
                        ↑  
                        means "add in the math library"
```

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