C - Bit Fields

Suppose your C program contains a number of TRUE/FALSE variables grouped in a structure called status, as follows −

struct {

unsigned int widthValidated;

unsigned int heightValidated;

} status;

This structure requires 8 bytes of memory space but in actual, we are going to store either 0 or 1 in each of the variables. The C programming language offers a better way to utilize the memory space in such situations.

If you are using such variables inside a structure then you can define the width of a variable which tells the C compiler that you are going to use only those number of bytes. For example, the above structure can be re-written as follows −

struct {

unsigned int widthValidated : 1;

unsigned int heightValidated : 1;

} status;

The above structure requires 4 bytes of memory space for status variable, but only 2 bits will be used to store the values.

If you will use up to 32 variables each one with a width of 1 bit, then also the status structure will use 4 bytes. However as soon as you have 33 variables, it will allocate the next slot of the memory and it will start using 8 bytes. Let us check the following example to understand the concept −

[Live Demo](http://tpcg.io/0YmfqO)

#include <stdio.h>

#include <string.h>

/\* define simple structure \*/

struct {

unsigned int widthValidated;

unsigned int heightValidated;

} status1;

/\* define a structure with bit fields \*/

struct {

unsigned int widthValidated : 1;

unsigned int heightValidated : 1;

} status2;

int main( ) {

printf( "Memory size occupied by status1 : %d\n", sizeof(status1));

printf( "Memory size occupied by status2 : %d\n", sizeof(status2));

return 0;

}

When the above code is compiled and executed, it produces the following result −

Memory size occupied by status1 : 8

Memory size occupied by status2 : 4

Bit Field Declaration

The declaration of a bit-field has the following form inside a structure −

struct {

type [member\_name] : width ;

};

The following table describes the variable elements of a bit field −

|  |  |
| --- | --- |
| **Sr.No.** | **Element & Description** |
| 1 | **type**  An integer type that determines how a bit-field's value is interpreted. The type may be int, signed int, or unsigned int. |
| 2 | **member\_name**  The name of the bit-field. |
| 3 | **width**  The number of bits in the bit-field. The width must be less than or equal to the bit width of the specified type. |

The variables defined with a predefined width are called **bit fields**. A bit field can hold more than a single bit; for example, if you need a variable to store a value from 0 to 7, then you can define a bit field with a width of 3 bits as follows −

struct {

unsigned int age : 3;

} Age;

The above structure definition instructs the C compiler that the age variable is going to use only 3 bits to store the value. If you try to use more than 3 bits, then it will not allow you to do so. Let us try the following example −

[Live Demo](http://tpcg.io/wVJ3IM)

#include <stdio.h>

#include <string.h>

struct {

unsigned int age : 3;

} Age;

int main( ) {

Age.age = 4;

printf( "Sizeof( Age ) : %d\n", sizeof(Age) );

printf( "Age.age : %d\n", Age.age );

Age.age = 7;

printf( "Age.age : %d\n", Age.age );

Age.age = 8;

printf( "Age.age : %d\n", Age.age );

return 0;

}

When the above code is compiled it will compile with a warning and when executed, it produces the following result −

Sizeof( Age ) : 4

Age.age : 4

Age.age : 7

Age.age : 0