

Swap bits in a given number

Given a number x and two positions (from right side) in binary representation of x, write a function that swaps n bits at given two positions and returns the result. It is also given that the two sets of bits do not overlap.

Examples:

Let p1 and p2 be the two given positions.

Example 1

Input:

x = 47 (00101111)

p1 = 1 (Start from second bit from right side)

p2 = 5 (Start from 6th bit from right side)

n = 3 (No of bits to be swapped)

Output:

227 (11100011)

The 3 bits starting from the second bit (from right side) are swapped with 3 bits starting from 6th position (from right side)

Example 2

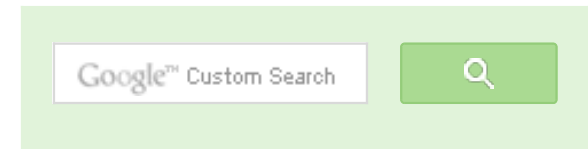
Input:

x = 28 (11100)

p1 = 0 (Start from first bit from right side)

p2 = 3 (Start from 4th bit from right side)

n = 2 (No of bits to be swapped)



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Output:

7 (00111)

The 2 bits starting from 0th position (from right side) are swapped with 2 bits starting from 4th position (from right side)

Solution

We need to swap two sets of bits. XOR can be used in a similar way as it is used to **swap 2 numbers**. Following is the algorithm.

1) Move all bits of first set to rightmost side

```
set1 = (x >> p1) & ((1U << n) - 1)
```

Here the expression $(1U \ll n) - 1$ gives a number that contains last n bits set and other bits as 0. We do & with this expression so that bits other than the last n bits become 0.

2) Move all bits of second set to rightmost side

```
set2 = (x >> p2) & ((1U << n) - 1)
```

3) XOR the two sets of bits

```
xor = (set1 ^ set2)
```

4) Put the xor bits back to their original positions.

```
xor = (xor << p1) | (xor << p2)
```

5) Finally, XOR the xor with original number so that the two sets are swapped.

```
result = x ^ xor
```

Implementation:

```
#include<stdio.h>
```

```
int swapBits(unsigned int x, unsigned int p1, unsigned int p2, unsigned int n)
{
    /* Move all bits of first set to rightmost side */
    unsigned int set1 = (x >> p1) & ((1U << n) - 1);

    /* Move all bits of second set to rightmost side */
    unsigned int set2 = (x >> p2) & ((1U << n) - 1);

    /* XOR the two sets */
    unsigned int xor = (set1 ^ set2);
```



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```

    /* Put the xor bits back to their original positions */
    xor = (xor << p1) | (xor << p2);

    /* XOR the 'xor' with the original number so that the
       two sets are swapped */
    unsigned int result = x ^ xor;

    return result;
}

/* Drier program to test above function*/
int main()
{
    int res = swapBits(28, 0, 3, 2);
    printf("\nResult = %d ", res);
    return 0;
}

```

Output:

```
Result = 7
```

Following is a shorter implementation of the same logic

```

int swapBits(unsigned int x, unsigned int p1, unsigned int p2, unsigned int n)
{
    /* xor contains xor of two sets */
    unsigned int xor = ((x >> p1) ^ (x >> p2)) & ((1U << n) - 1);

    /* To swap two sets, we need to again XOR the xor with original sets */
    return x ^ ((xor << p1) | (xor << p2));
}

```

References:

Swapping individual bits with XOR

Please write comments if you find anything incorrect, or you want to share more information about the topic discussed above.

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Rawat · 2 years ago

This solution works fine, I first copied the n-bits from p1 position to p2 and then p2 to p1 position. Basic swap Algorithm !

```
#include <iostream>
using namespace std;
int main()
{
    int val, p1, p2, n, org, orgN, newVal=0, ntNum=0;
    cin>>val>>p1>>p2>>n;
    org=val;orgN=n;
    while(n-->0)
        newVal|=(val&(1<<(p1+n)))>0?(1<<(p1+n)):0;
    newVal<<=(p2-p1);
    n=orgN;
    while(n-->0)
        ntNum|=1<<(p2+n);
    val&=~ntNum;
```

[see more](#)

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kavish · 2 years ago

could you please explain the role of $(1 \ll n) - 1$ in detail?

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Ram → kavish · 2 years ago

Kavish,

Here n signifies the number of bits to be swapped.

consider n=2

1U<<2 mean it gives 0100 (ignoring the other nibbles on MSB side)

now when you subtract 1 from it, it will become 0011

Idea is to have only those n bits rest of them are masked to zero.

^ | v · Reply · Share ›



akshayjohri89 · 2 years ago

How about just

Create a mask of all 1s for 1st set by

```
/* Paste your code here (You may delete these lines if not writing cor
```

```
unsigned int swapbits(unsigned int x,int p1,int p2, int n){  
    unsigned int mask1,mask2,temp;  
    mask1=1<<p1;
```

```
//Create mask1  
for(i=0;i<n-1;i++)  
    mask1=mask1|(mask1<<1);
```

```
//Keeping a copy of mask1 in temp  
temp=mask1;
```

```
//Create mask2 by shifting mask1 by p2-p1
```

[see more](#)

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Tushar_Pucsd · 2 years ago

If any one explain ($1U \ll n$) how it exucute?

^ | v · Reply · Share ›



ish7 · 2 years ago

Awesome :)

^ | v · Reply · Share ›



Venki · 2 years ago

I guess the positions should not overlap.

^ | v · Reply · Share ›



GeeksforGeeks → Venki · 2 years ago

Thanks Venki. This point has been added to the problem statement.

^ | v · Reply · Share ›



Pavan → GeeksforGeeks · a year ago

In the example given, if $x=47$, $n=3$, $p_1=1$, $p_2=3$, the positions o
works currently here as well. Please let me know why does this
does not overlap.

```
/* Paste your code here (You may delete these lines if r
```

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