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Data Structures Algorithms Interview Preparation Topic-wise Practice C++ Java Python

Bits manipulation (Important tactics)

Difficulty Level : Medium • Last Updated : 18 May, 2021

Prerequisites : Bitwise operators in C, Bitwise Hacks for Competitive Programming, Bit Tricks for Competitive Programming

1. Compute XOR from 1 to n (direct method) :

CPP

```cpp
// Direct XOR of all numbers from 1 to n
int computeXOR(int n)
{
    if (n % 4 == 0)
        return n;
    if (n % 4 == 1)
        return 1;
    if (n % 4 == 2)
        return n + 1;
    else
        return 0;
}
```

1.

2. We can quickly calculate the total number of combinations with numbers smaller than or equal to a number whose sum and XOR are equal. Instead of using looping (Brute force method), we can directly find it by a mathematical trick i.e.

```
// Refer Equal Sum and XOR for details.
Answer = pow(2, count of zero bits)
```

1. How to know if a number is a power of 2?

CPP

```
//  Function to check if x is power of 2
bool isPowerOfTwo(int x)
{
     // First x in the below expression is
     // for  the case when x is 0
     return x && (!(x & (x - 1)));
}
```

1. Refer check if a number is power of two for details.
2. Find XOR of all subsets of a set. We can do it in O(1) time. The answer is always 0 if the given set has more than one element. For sets with a single element, the answer is the value of single element. Refer XOR of the XOR's of all subsets for details.
3. We can quickly find number of leading, trailing zeroes and number of 1's in a binary code of an integer in C++ using GCC. It can be done by using inbuilt function i.e.

```
Number of leading zeroes: builtin_clz(x)
Number of trailing zeroes : builtin_ctz(x)
Number of 1-bits: __builtin_popcount(x)
```

1. Refer GCC inbuilt functions for details.

```
// Conversion into Binary code//
#include <iostream>
using namespace std;

int main()
{
    auto number = 0b011;
    cout << number;
    return 0;
}
```

1.

```
Output: 3
```

1. The Quickest way to swap two numbers:

```
a ^= b;
b ^= a;
a ^= b;
```

1. Refer swap two numbers for details.

2. Simple approach to flip the bits of a number: It can be done in a simple way, just simply subtract the number from the value obtained when all the bits are equal to 1.
   For example:

```
Number : Given Number
Value  : A number with all bits set in given number.
Flipped number = Value – Number.

Example :
```

1. We can find the most significant set bit in O(1) time for a fixed size integer. For example below code is for 32-bit integer.

C

```c
int setBitNumber(int n)
{
    // Below steps set bits after
    // MSB (including MSB)

    // Suppose n is 273 (binary
    // is 100010001). It does following
    // 100010001 | 010001000 = 110011001
    n |= n>>1;

    // This makes sure 4 bits
    // (From MSB and including MSB)
    // are set. It does following
    // 110011001 | 001100110 = 111111111
    n |= n>>2;

    n |= n>>4;
    n |= n>>8;
    n |= n>>16;

    // Increment n by 1 so that
    // there is only one set bit
    // which is just before original
    // MSB. n now becomes 1000000000
    n = n + 1;

    // Return original MSB after shifting.
    // n now becomes 100000000
    return (n >> 1);
}
```

1. Refer Find most significant set bit of a number for details.

2. We can quickly check if bits in a number are in alternate pattern (like 101010). We compute n ^ (n >> 1). If n has an alternate pattern, then n ^ (n >> 1) operation will

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