Count set bits in an integer

Write an efficient program to count number of 1s in binary representation of an integer.

1. Simple Method Loop through all bits in an integer, check if a bit is set and if it is then increment the set bit count. See below program.

```
/* Function to get no of set bits in binary
   representation of passed binary no. */
int countSetBits(unsigned int n)
{
  unsigned int count = 0;
  while(n)
  {
    count += n & 1;
    n >>= 1;
  }
  return count;
}

/* Program to test function countSetBits */
int main()
{
    int i = 9;
    printf("%d", countSetBits(i));
    getchar();
    return 0;
}
```

Time Complexity: (-)(logn) (Theta of logn)

2. Brian Kernighan's Algorithm:
Subtraction of 1 from a number toggles all the bits (from right to left) till the rightmost set

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bit(including the righmost set bit). So if we subtract a number by 1 and do bitwise & with itself (n & (n-1)), we unset the righmost set bit. If we do n & (n-1) in a loop and count the no of times loop executes we get the set bit count.
Beauty of the this solution is number of times it loops is equal to the number of set bits in a given integer.

```
1  Initialize count: = 0
2  If integer n is not zero
   (a) Do bitwise & with (n-1) and assign the value back to n
       n: = n&(n-1)
   (b) Increment count by 1
   (c) go to step 2
3  Else return count
```

Implementation of Brian Kernighan's Algorithm:

```
#include<stdio.h>

/* Function to get no of set bits in binary
   representation of passed binary no. */
int countSetBits(int n)
{
    unsigned int count = 0;
    while (n)
    {
      n &= (n-1) ;
      count++;
    }
    return count;
}

/* Program to test function countSetBits */
int main()
{
    int i = 9;
    printf("%d", countSetBits(i));
    getchar();
    return 0;
}
```

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Example for Brian Kernighan's Algorithm:

```
n =  9 (1001)
count = 0

Since 9 > 0, subtract by 1 and do bitwise & with (9-1)
n = 9&8  (1001 & 1000)
n = 8
count  = 1

Since 8 > 0, subtract by 1 and do bitwise & with (8-1)
n = 8&7  (1000 & 0111)
n = 0
count = 2

Since n = 0, return count which is 2 now.
```


Time Complexity: O(logn)

3. Using Lookup table: We can count bits in O(1) time using lookup table. Please see http://graphics.stanford.edu/~seander/bithacks.html#CountBitsSetTable for details.

You can find one use of counting set bits at http://geeksforgeeks.org/?p=1465

References:

http://graphics.stanford.edu/~seander/bithacks.html#CountBitsSetNaive

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