

Royal University of Bhutan

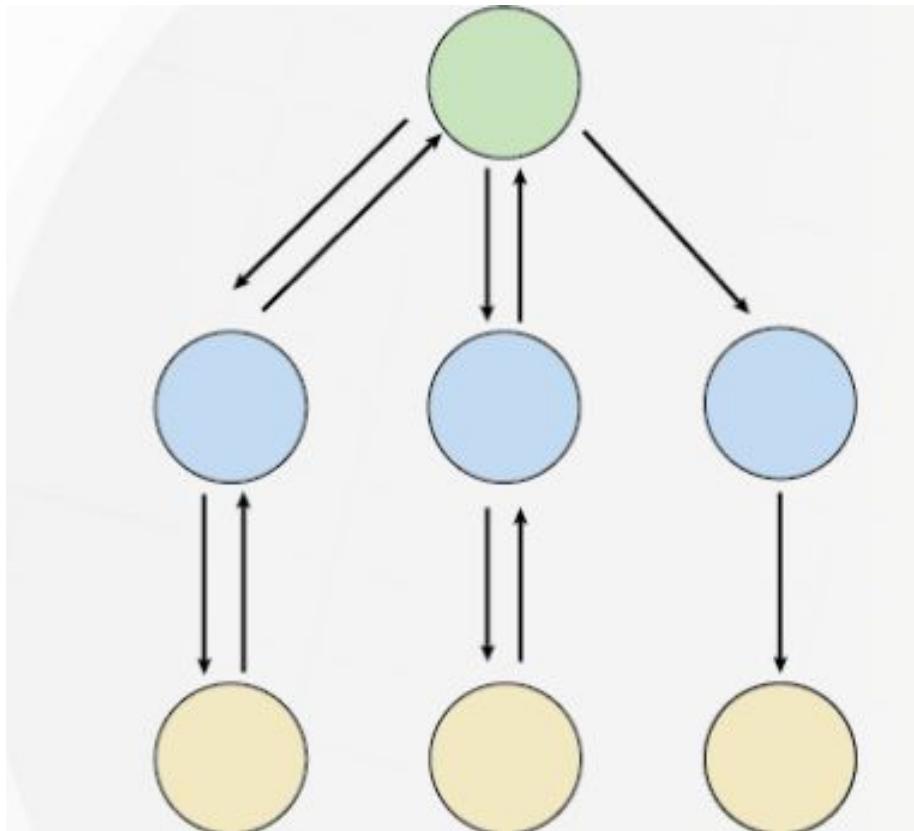
Unit IV: Introduction to Computational Problems & Algorithms

Programming Methodology (CSF101)

Outline

- Backtracking : Combination Sum, Word Search, Permutations
- Bit Manipulation : Number of 1 Bits, Counting Bits, Reverse Bits, Missing Numbers

Backtracking



Backtracking algorithm

Backtrack(s)

if s is not a solution

 return false

if s is a new solution

 add to list of solutions

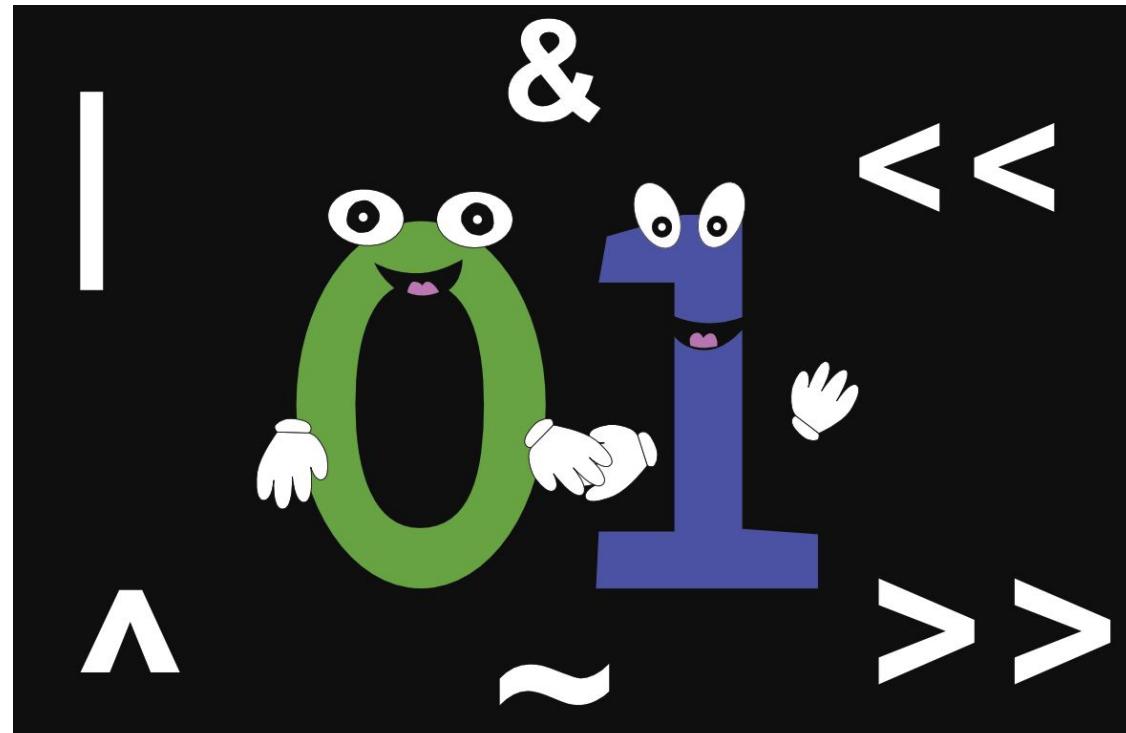
 backtrack(expand s)

When can backtracking algorithm be used?

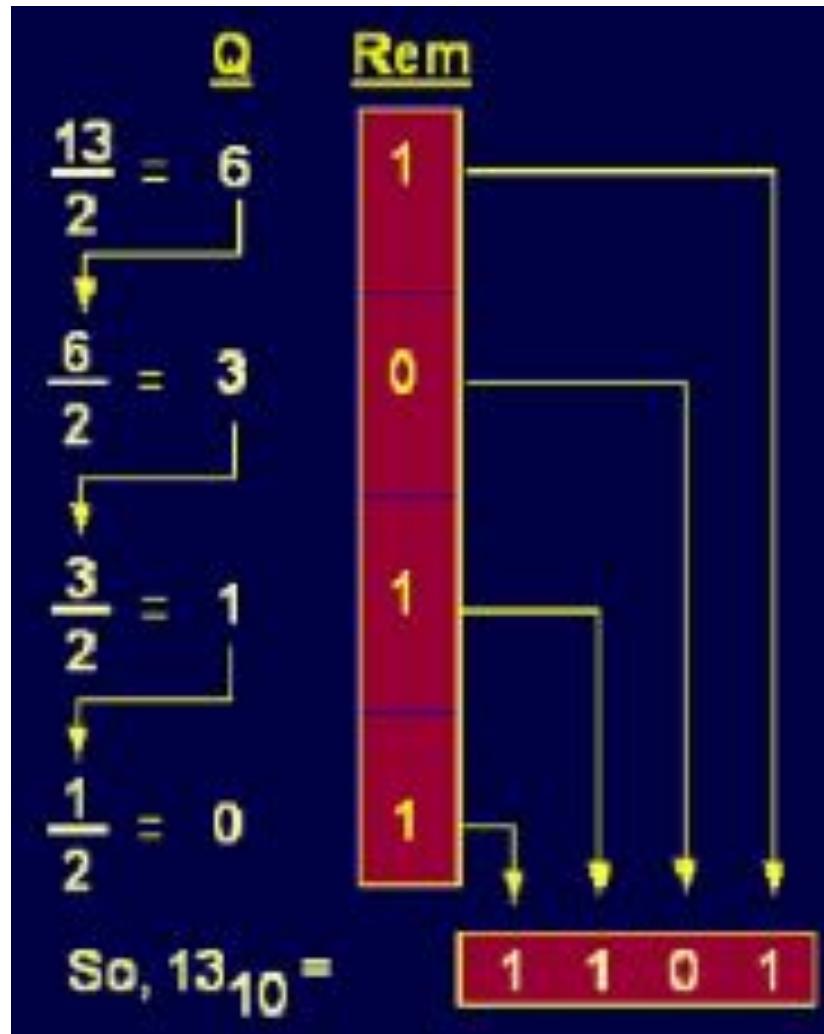
There are multiple possible solutions to the problem

The problem can be broken down into smaller subproblems

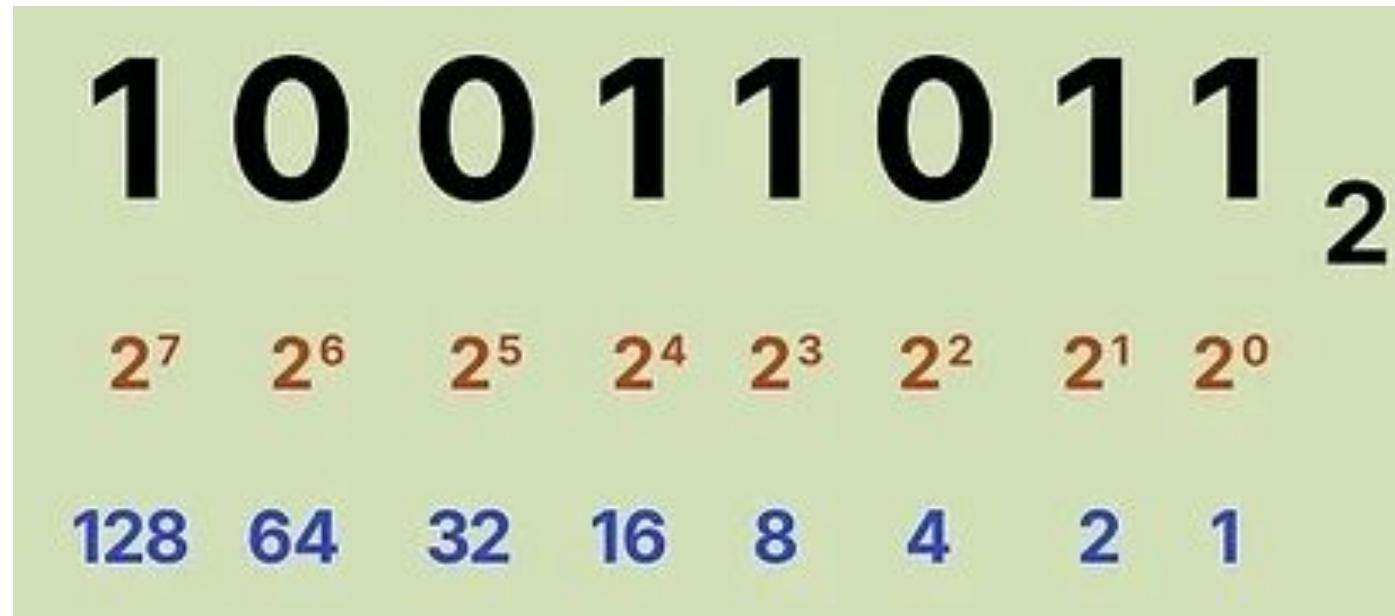
Bit Manipulation



Decimal to binary number conversion



Binary to decimal number conversion



Some bitwise operators

Operator	Description
&	bitwise AND
	bitwise OR
^	bitwise exclusive OR
<<	shift left
>>	shift right
~	one's complement

Bit representation of number

To represent **-34** in 2's complement form

$$\begin{array}{rcl} +34 & = & 0 \textcolor{red}{0} \textcolor{blue}{1} \textcolor{blue}{0} \textcolor{blue}{0} \textcolor{blue}{0} \textcolor{blue}{1} \textcolor{blue}{0} \\ & & \downarrow \quad \downarrow \quad \downarrow \quad \downarrow \quad \downarrow \quad \downarrow \quad \downarrow \\ & & 1 \textcolor{red}{1} \textcolor{green}{0} \textcolor{green}{1} \textcolor{green}{1} \textcolor{green}{1} \textcolor{green}{0} \textcolor{green}{1} & \text{(1's complement of +34)} \\ + & & \hline & 1 \\ -34 & = & \textcolor{red}{1} \textcolor{green}{1} \textcolor{green}{0} \textcolor{green}{1} \textcolor{green}{1} \textcolor{green}{1} \textcolor{green}{1} \textcolor{green}{0} & \text{(2's complement of +34)} \end{array}$$

Bit methods

```
def getBit( num, i):  
  
    # Return true if the ith bit is  
    # set. Otherwise return false  
    return ((num & (1 << i)) != 0)
```

```
def setBit( num, i):  
  
    # Sets the ith bit and return  
    # the updated value  
    return num | (1 << i)
```

```
def clearBit( num, i):  
  
    # Create the mask for the ith  
    # bit unset  
    mask = ~(1 << i)  
  
    # Return the updated value  
    return num & mask
```

Leetcode problems of backtracking

1. Combination-sum

Leetcode problems of bit manipulation

1. [number-of-1-bits](#)

Reference

GfG (2024) Backtracking algorithm, GeeksforGeeks. Retrieved from
<https://www.geeksforgeeks.org/backtracking-algorithms/>

GfG (2023a) All about bit manipulation, GeeksforGeeks. Available at:
<https://www.geeksforgeeks.org/all-about-bit-manipulation/>

THANK YOU

