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SE COMP-B
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Experiment No: 12

AIM: Implementation of sum of subset problem using Backtracking

THEORY:

Given *n* distinct positive numbers(called weights), we need to find all combinations of these numbers whose sums are *m.* This is called the *sum of subsets problem.*

The problem is efficiently solved in programming using a concept called Backtracking.

Backtracking is an algorithmic technique for solving problems recursively by trying to build a solution incrementally, one piece at a time, removing those solutions that fail to satisfy the constraints of the problem at any point of time.

The following bounding functions are used:

1. $\sum_{i=1}^{k} wixi + \sum_{i=k+1}^{n} wi \geq m$
2. $\sum_{i=1}^{k} wixi + w_{k+1} \leq m$

ALGORITHM:

Algorithm SumOfSub(s,k,r)
// Find all subsets of w[1 :n] that sum to m. The values of x[j],
// 1≤j < k have already been determined.
// The w[j]'s are in nondecreasing order.
// It is assumed that w[1] ≤ m
{
// Generate left child. Note: s+w[k] < m since B_{k-1} is true.
x[k]:=1;
if (s+w[k] =m) then write (x[1:k]);// Subset found
// There is no recursive call here as w[j] >0, 1≤j ≤n.

else if (s+w[k] +w[k+1]≤m) 12
thenSumOfSub(s+w[k],k+1,r-w[k]);

// Generate right child and evaluate B_k.

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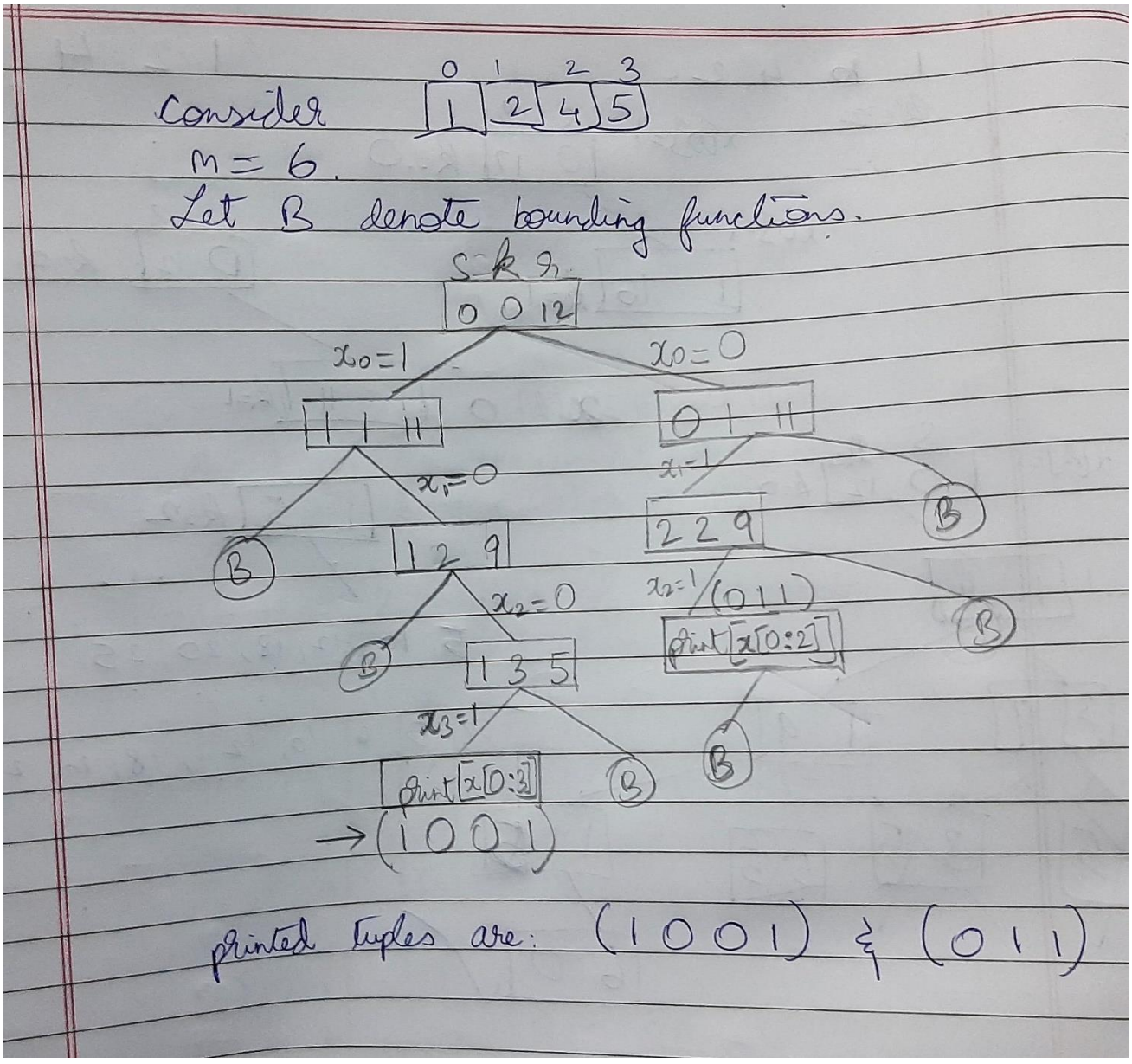
```
        if ((s + r – w[k] ≥ m) and (s + w[k+1] ≤ m)) then
        {
                x[k]=0;
                SumOfSub(s,k+1,r-w[k]);
        }
}
```

Time Complexity

- The time complexity of this algorithm is O (2^n).

Problem Tracing



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PROGRAM IMPLEMENTATION:

```
#include<iostream>

using namespace std;

int n,m,*w,*x;        //soln vector


void show_set(int k)

{

        cout<<"( ";

        for(int i=0;i<=k;i++)

                cout<<x[i]<<" ";

        cout<<")"<<endl;


}

void sum_of_sub(int s, int k, int r)

{

        x[k] = 1;


        if(s+w[k] == m)

                show_set(k);


        else if(s + w[k] + w[k+1] <=m)              //current sum is less than or equal to m

                sum_of_sub(s+w[k],k+1,r-w[k]);


        if( (s + r - w[k] >= m) && (s + w[k+1] <=m))              //bounding function says that
```

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```
		{
	//w obtained so far + remaining w
			x[k] = 0;                                                    //must
be >=m
			sum_of_sub(s,k+1,r-w[k]);
		}
	//and the w obtained so far + next

	//w must be <=m
}

int main()
{
	int r=0;		//temp sum
	cout<<"Enter number of elements:\n";
	cin>>n;

	cout<<"Enter "<<n<<" elements: ";

	w=new int[n];

	for(int i=0;i<n;i++)
		cin>>w[i],r+=w[i];



	x = new int[n];
```

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```
        cout<<"\nEnter the sum: ";
        cin>>m;



        for(int i=0;i<n;i++)
                x[i]=0;


        int s=0,k=0;
        sum_of_sub(s,k,r);


        return 0;
}
```

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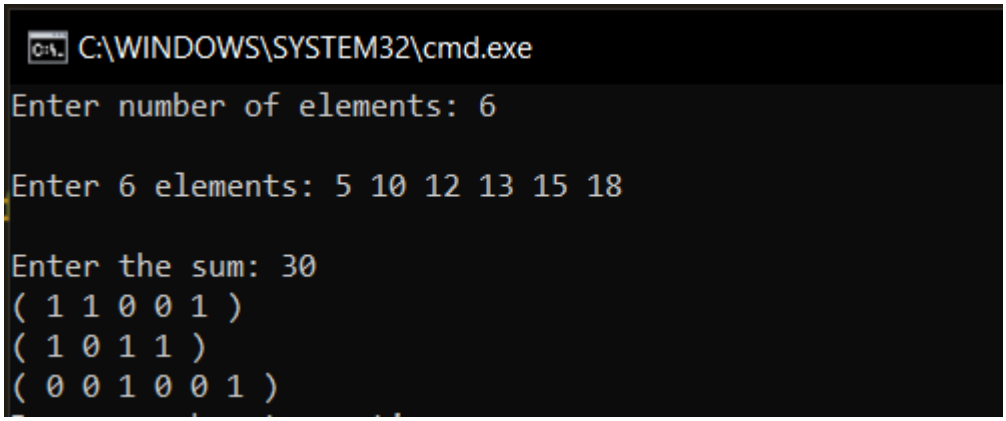
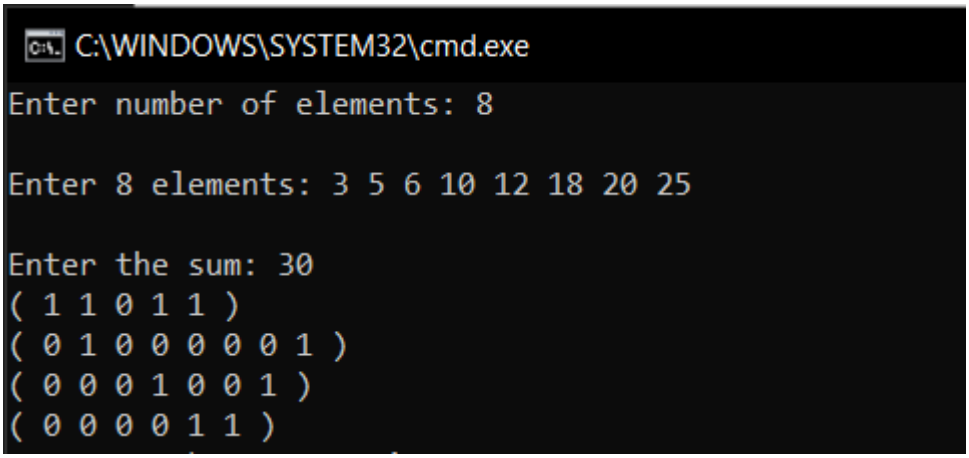
OUTPUTS:

1. When n=6



2. When n=8



Conclusion:

- This algorithm works when the elements are arranged in non-decreasing order of their weights.
- Time complexity of the algorithm is O(2^n)