Experiment-6

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1. **Aim:** Develop a program and analyze complexity to implement subset-sum problem using Dynamic Programming.

2. **Objective:** To implement the Subset Sum Problem using Dynamic Programming in C++ and understand how dynamic programming efficiently solves problems involving subsets and target sums.

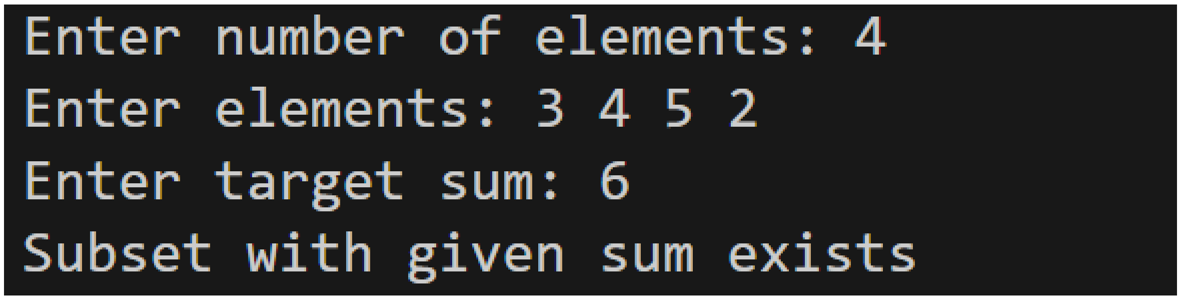
3. **Procedure:**

```
1. Start
2. Input the number of elements n and the array arr[].
3. Input the target sum sum.
4. Create a 2D boolean DP table dp[n+1][sum+1].
5. Initialize dp[i][0] = true for all i and dp[0][j] = false for all j > 0.
6. For each element i from 1 to n:
       For each sum j from 1 to sum:
           If arr[i-1] > j, then dp[i][j] = dp[i-1][j].
           Else dp[i][j] = dp[i-1][j] || dp[i-1][j - arr[i-1]].
7. The final answer is dp[n][sum].
8. If true, print subset exists; otherwise, it does not.
```

4. **Code:**

```
#include <iostream>
#include <vector>
using namespace std;
int main() {
   int n, sum;
   cout << "Enter number of elements: ";
   cin >> n;
   vector<int> arr(n);
   cout << "Enter elements: ";
   for (int i = 0; i < n; i++) cin >> arr[i];
   cout << "Enter target sum: ";
cin >> sum;
   vector<vector<bool>> dp(n + 1, vector<bool>(sum + 1, false));
   for (int i = 0; i <= n; i++) dp[i][0] = true;
   for (int i = 1; i <= n; i++) {
       for (int j = 1; j <= sum; j++) {
           if (arr[i - 1] > j) dp[i][j] = dp[i - 1][j];
           else dp[i][j] = dp[i - 1][j] || dp[i - 1][j - arr[i - 1]];
       }
   }
   if (dp[n][sum]) cout << "Subset with given sum exists";
   else cout << "Subset with given sum does not exist";
   return 0;
}
```

5. Observations:



```
Enter number of elements: 4
Enter elements: 3 4 5 2
Enter target sum: 6
Subset with given sum exists
```

6. Time Complexity:

- O(n × sum) in every case

7. Learning Outcome:

❖ Learned how to implement the Subset Sum Problem using Dynamic Programming in C++.
❖ Understood the concept of overlapping subproblems and optimal substructure in DP.
❖ Gained practical experience in constructing and filling a DP table for subset evaluation.
❖ Strengthened understanding of problem-solving using recursive and iterative DP approaches.
❖ Learned to analyze the time and space complexity of dynamic programming solutions.