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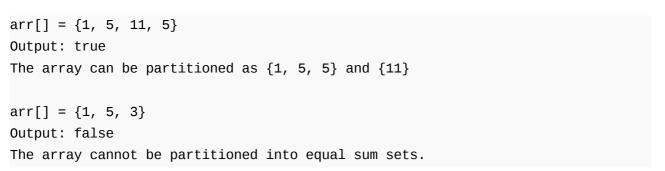
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# Dynamic Programming | Set 18 (Partition problem)

Partition problem is to determine whether a given set can be partitioned into two subsets such that the sum of elements in both subsets is same.

### Examples



Following are the two main steps to solve this problem:

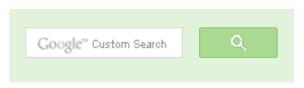
- 1) Calculate sum of the array. If sum is odd, there can not be two subsets with equal sum, so return false.
- 2) If sum of array elements is even, calculate sum/2 and find a subset of array with sum equal to sum/2.

The first step is simple. The second step is crucial, it can be solved either using recursion or Dynamic Programming.

### **Recursive Solution**

Following is the recursive property of the second step mentioned above.

Let isSubsetSum(arr, n, sum/2) be the function that returns true if there is a subset of arr[0..n-1] with sum equal to sum/2





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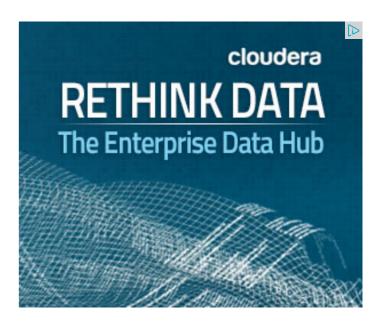
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```
The isSubsetSum problem can be divided into two subproblems
 a) isSubsetSum() without considering last element
   (reducing n to n-1)
 b) isSubsetSum considering the last element
   (reducing sum/2 by arr[n-1] and n to n-1)
If any of the above the above subproblems return true, then return true.
isSubsetSum (arr, n, sum/2) = isSubsetSum (arr, n-1, sum/2) ||
                           isSubsetSum (arr, n-1, sum/2 - arr[n-1])
// A recursive solution for partition problem
#include <stdio.h>
// A utility function that returns true if there is a subset of arr[]
// with sun equal to given sum
bool isSubsetSum (int arr[], int n, int sum)
   // Base Cases
   if (sum == 0)
     return true;
   if (n == 0 && sum != 0)
     return false;
   // If last element is greater than sum, then ignore it
  if (arr[n-1] > sum)
     return isSubsetSum (arr, n-1, sum);
   /* else, check if sum can be obtained by any of the following
      (a) including the last element
      (b) excluding the last element
   return isSubsetSum (arr, n-1, sum) || isSubsetSum (arr, n-1, sum-ar
// Returns true if arr[] can be partitioned in two subsets of
// equal sum, otherwise false
bool findPartiion (int arr[], int n)
    // Calculate sum of the elements in array
    int sum = 0;
    for (int i = 0; i < n; i++)
       sum += arr[i];
    // If sum is odd, there cannot be two subsets with equal sum
```



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```
if (sum%2 != 0)
       return false;
    // Find if there is subset with sum equal to half of total sum
    return isSubsetSum (arr, n, sum/2);
// Driver program to test above function
int main()
  int arr[] = \{3, 1, 5, 9, 12\};
  int n = sizeof(arr)/sizeof(arr[0]);
  if (findPartiion(arr, n) == true)
    printf("Can be divided into two subsets of equal sum");
  else
    printf("Can not be divided into two subsets of equal sum");
  getchar();
  return 0;
```

# Output:

Can be divided into two subsets of equal sum

Time Complexity: O(2<sup>n</sup>) In worst case, this solution tries two possibilities (whether to include or exclude) for every element.

# **Dynamic Programming Solution**

The problem can be solved using dynamic programming when the sum of the elements is not too big. We can create a 2D array part[][] of size (sum/2)\*(n+1). And we can construct the solution in bottom up manner such that every filled entry has following property

```
part[i][j] = true if a subset of {arr[0], arr[1], ..arr[j-1]} has sum
           equal to i, otherwise false
// A Dynamic Programming solution to partition problem
#include <stdio.h>
// Returns true if arr[] can be partitioned in two subsets of
// equal sum, otherwise false
bool findPartiion (int arr[], int n)
    int sum = 0;
```

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# **Automation**

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```
int i, j;
    // Caculcate sun of all elements
    for (i = 0; i < n; i++)</pre>
      sum += arr[i];
    if (sum%2 != 0)
       return false;
    bool part[sum/2+1][n+1];
    // initialize top row as true
    for (i = 0; i <= n; i++)
      part[0][i] = true;
    // initialize leftmost column, except part[0][0], as 0
    for (i = 1; i <= sum/2; i++)</pre>
      part[i][0] = false;
     // Fill the partition table in botton up manner
     for (i = 1; i <= sum/2; i++)
       for (j = 1; j \le n; j++)
         part[i][j] = part[i][j-1];
         if (i >= arr[j-1])
           part[i][j] = part[i][j] || part[i - arr[j-1]][j-1];
    /* // uncomment this part to print table
     for (i = 0; i \le sum/2; i++)
       for (j = 0; j \le n; j++)
          printf ("%4d", part[i][j]);
       printf("\n");
     } */
     return part[sum/2][n];
// Driver program to test above funtion
int main()
  int arr[] = {3, 1, 1, 2, 2, 1};
  int n = sizeof(arr)/sizeof(arr[0]);
```

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Aman Hi, Why arent we checking for conditions...

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kzs please provide solution for the problem...

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### Sanjay Agarwal bool

tree::Root\_to\_leaf\_path\_given\_sum(tree...

Root to leaf path sum equal to a given number · 1

hour ago

**GOPI GOPINATH** @admin Highlight this sentence "We can easily...

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hour ago

**newCoder3006** If the array contains negative numbers also. We...

Find subarray with given sum · 1 hour ago

newCoder3006 Code without using while loop. We can do it...

Find subarray with given sum · 1 hour ago

### AdChoices [>

- ▶ Java Array
- ▶ Partition
- String Java

if (findPartiion(arr, n) == true)

```
printf("Can be divided into two subsets of equal sum");
else
   printf("Can not be divided into two subsets of equal sum");
getchar();
return 0;
```

# Output:

Can be divided into two subsets of equal sum

Following diagram shows the values in partition table. The diagram is taken form the wiki page of partition problem.

The entry part[i][j] indicates whether there is a subset of {arr[0], arr[1], .. arr[j-1]} that sums to i

	{}	{3}	{3,1}	{3,1,1}	{3,1,1,2}	{3,1,1,2,2}	{3,1,1,2,2,1}
0	True	True	True	True	True	True	True
1	False	False	True	True	True	True	True
2	False	False	False	True	True	True	True
3	False	True	True	True	True	True	True
4	False	False	True	True	True	True	True
5	False	False	False	True	True	True	True

Dynamic Programming table for  $arr[] = {3,1,1,2,2,1}$ 

Time Complexity: O(sum\*n) Auxiliary Space: O(sum\*n)

Please note that this solution will not be feasible for arrays with big sum.

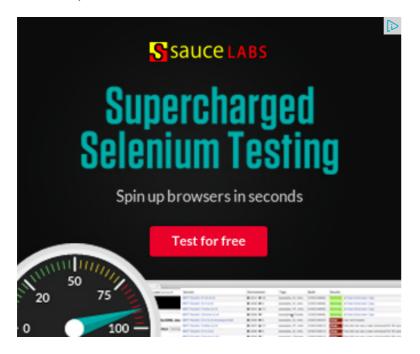
References:

- AdChoices [>
- ► Int
- ► SUM
- ▶ Oracle Java

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- ▶ Java Object
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Please write comments if you find anything incorrect, or you want to share more information about the topic discussed above.



# Related Tpoics:

- Remove minimum elements from either side such that 2\*min becomes more than max
- Divide and Conquer | Set 6 (Search in a Row-wise and Column-wise Sorted 2D Array)
- Bucket Sort
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- Find the number of zeroes
- Find if there is a subarray with 0 sum
- Divide and Conquer | Set 5 (Strassen's Matrix Multiplication)
- Count all possible groups of size 2 or 3 that have sum as multiple of 3



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Rohit Sharma • a month ago

here is the code with time complexity-0(n^2)

\_\_\_\_\_\_

algorithm---

1-find sum of array.

if odd return false;

sum=sum/2;

2.sort array by using any method.

3.apply dynamic algorithm similar to find sub array given sum.

here is code!!

==========

#include<stdio.h>

see more





Dante Fan → Rohit Sharma • 5 days ago

It's an NP-complete problem, no polynomial solution yet...



**prashant** • 4 months ago

here is the naive recursive approach which returns the min differnece detweer

```
int min(int a,int b)
return a>b?b:a;
int fun(int arr[],int low,int high,int s1,int s2)
if(low>high)
return s1>s2?(s1-s2):(s2-s1);
return min(fun(arr.low+1.high.s1+arrflow1.s2).fun(arr.low+1.high.s1.s2+arrflow
                                                        see more
^ V ·
```



open in browser

Aja Huang • 7 months ago

There is a much faster and simpler solution using STL bitset. https://github.com/swem/UVa-On...

2 ^ \ \ .

sumit dey • 9 months ago

Here is the java version of the same problem, it will also print the solution of the solution. No pood of corted input and it works for possitive solution. The printed PRO version Are you a developer? Try out the HTML to PDF API

solution. No need of sorted input and it works for negative solution. The printed subset, other subset will be the excluded element.

```
import java.util.LinkedHashMap;
import java.util.Map;

public class PartitionSumSubsetProblem {
    public static class CachedDataAttr {
        int sum;
        int indexOfArray;
        int bfrSumDiff;
```

see more

1 ~ | ~ .



Soumak Datta • 9 months ago



Sunil Singhal • 9 months ago

Will Not. Consider a case {5,9,9,13}





Kuldeep Tiwari • 10 months ago

Will work. You have not sorted the array here.



Aman Jain • 10 months ago

if array contain -ve elements too, then this code can work for it too.. sum can be any value..

```
[sourcecode language="C++"]
#include<iostream>
using namespace std;
int func(int *arr,int n,int sum)
{
  int x=0;
  int y=0;
  int i,j;
  for(i=1;i<=n;i++)
  {
    if(arr[i]>=0)
    {
      x+=arr[i];
  }
}
```

see more



open in browser

Sandeep Jain • a year ago

This doesn&#039t work for all cases. For example, it won&#039t work for {5, {3, 3}.

A | V .

^ V ·

GeeksforGeeks • a year ago

Siddhartha: Please take a closer look at the problem statement. You need to delement must be in one of the two parts. In your example, you have ignored 15 PRO version. Are you a developer? Try out the HTML to PDF API

element must be in one of the two parts. In your example, you have ignored to



Puneet Garg • a year ago another solution.

at first, sort array in decreasing order. then take two variable as sum1 & sum2 1st element to sum1 & add 2nd element to sum2. if sum1 < sum2 then add 3r then add 3rd element to sum2.continue up to last element. if sum1==sum2 the not.

A | V .



anonymous → Puneet Garg · 4 months ago for this {5, 5, 4, 3, 3} .. ??

^ V ·



anonymous → Puneet Garg • 4 months ago
if sum1 = sum2, then what to do? add to which sum?

^ V ·



Susheel Pandey • a year ago superb man :P

**^ \ \ .** 



**abhishek08aug** ⋅ a year ago Intelligent :D

 $/^{\ast}$  Paste your code here (You may delete these lines if not writing  $c\iota$ 

^ V



googlybhai • a year ago

Solution will work only for +ve numbers. So either we should change the proble





Siddhartha Sharma • a year ago

As mentioned above:-

Following are the two main steps to solve this problem:

- 1) Calculate sum of the array. If sum is odd, there can not be two subsets with
- 2) If sum of array elements is even, calculate sum/2 and find a subset of array

what if we have an array {15,10,10} which has sum odd (35) but can be broke equal sum contradicting point 1.

^ V ·



Siddhartha's Father → Siddhartha Sharma • 6 months ago

What are you son? Blind! Your Array contains 3 elements.

3 ^ 🗸 .



**anand** • a year ago

```
public class PartitionProblem {

    /**
    * @param args
    */
    public static void main(String[] args) {
        int A[] = {5, 5, 4, 3, 3};
        System.out.println(isSubSet(A, A.length));
    }

    private static boolean isSubSet(int[] A, int length) {
        int i,partialSum,sum = 0;
        for(i=0;i<length;i++){</pre>
```

```
sum +=A[i];
if(sum%2 == 1)return false;
```

see more



```
kT → anand · a year ago
```

@ anand,

I think your solution will fail for i/p: 3,4,8,9.

Please check and sorry if my observation is incorrect.

Thanks.



```
Patrick → kT · a year ago
```

@KT:

I modified anand's code and now it's working for all cases.

```
bool subPartition(int *A, int len){
       int sum=0, partitionSum;
       for(int i=0; i<len;i++){</pre>
                sum=sum+A[i];
       if(sum%2==1)
                return false;
       else{
                partitionSum=sum/2;
                qsort(A,len); //sort in decreasing order
                for(int i=0; i<len;i++){</pre>
                         while(partitionSum<A[i] && i<ler</pre>
```

i++:

partitionSum=partitionSum-A[i];

see more

Rahul Singh Patrick • a year ago
Patrick, what you are suggesting is a greedy approach.
{2,3,4,5,7,9}.



Patrick → anand · a year ago nice solution.... thanks





Raja · 2 years ago
Hi,

I would like to know In what cases sum is less than an array element(it might I numbers).

// If last element is greater than sum, then ignore it if (arr[n-1] > sum) return isSubsetSum (arr, n-1, sum);



Nikhil • 2 years ago

// If last element is greater than sum, then ignore it if (arr[n-1] > sum) return isSubsetSum (arr, n-1, sum);

Regarding this code,I think we should return false as question says we need to ignoring any element,the we will create more than 2 subsets.

Please correct me if I am wrong!!! A | V .



Nikhil • 2 years ago // If last element is greater than sum, then ignore it if (arr[n-1] > sum)return isSubsetSum (arr, n-1, sum);

Regarding this code, I think we should return false as question says we need to ignoring any element, the we will create more than 2 subsets.

Please correct me if I am wrong!!!

```
/^{\star} Paste your code here (You may delete these lines if not writing co
```



```
Nishant Mittal • 2 years ago
*can be done by recursion with O(n^2).
int32 t check sum (int32 t array[], int32 t i, int32 t sum) {
if (i<max) {
check sum (array, i+1, sum);
sum=sum-array[i];
if ( sum ==0 ) return ans=1;
check sum (array, i+1, sum);
```



**Anonymous** • 2 years ago im wondering if the condition should be:

```
if (i >= arr[j-1])
           part[i][j] = part[i][j-1] || part[i - arr[j-1]][j-1];
```



Mayautobot • 2 years ago

"Please note that this solution will not be feasible for arrays with big sum."

--->What can be the approach for finding solution with large sum?

^ V ·



```
Simpson • 2 years ago
#include
#include
#include
int compare(const void * a, const void * b)
return ( *(int*)a - *(int*)b );
int main()
int a[7];
int sum even ,sum,m,n,i,flag;
sum even=sum=m=flag=0;
n=6;
for( i=0;i<7;i++)
scanf("%d",&a[i]);
```

see more

A V .



keshav → Simpson • 2 years ago

Plz clearify ur method.

/\* Paste your code here (You may **delete** these lines **if not** wri



Abhinav Priyadarshi • 2 years ago

i think there is a error in explanation of part[i][j], it should be part[i][j] = true if a subset of {arr[0], arr[1], ..arr[j-1]} has sum equal to \*\*\*\* i \*\*\*\*

^ | v | •



**Abhinav Priyadarshi** → Abhinav Priyadarshi → 2 years ago \*\*\*\*\*\* are used to highlight.



GeeksforGeeks → Abhinav Priyadarshi • 2 years ago

@Abhinav Priyadarshi: Thanks for pointing this out. We have co



Ankit Gupta • 2 years ago

Hi, I am using a top-down recursive memoization to populate the cache array

# I want to know:

- 1. Whether following solution is correctly implemented.
- 2. I don't see the sub-problems being reused in the cache array so a bottom u entries unused (and populated nonethless).

```
int arr[] = {3, 1, 1, 2, 2, 1};
int N, S;
int cache[MAYN][MAYSUM]:
```

```
THE CACHE [HAVIN] [HAVOOH],
bool partition(int pos, int sum)
    if (sum == S>>1) {
        return true;
    if (pos == N || sum > S>>1) {
        ratura falasi
```

see more





Ankit Gupta → Ankit Gupta · 2 years ago

I have initialized cache to -1 and S to total Sum.

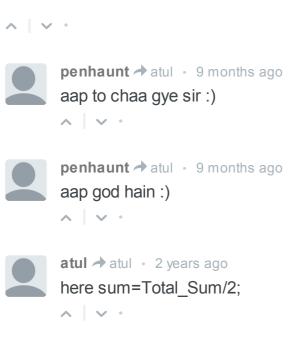




atul • 2 years ago

space optimized DP approach :-

```
part[0]=1;
for(i=0;i<n;i++)</pre>
   for(j=sum;j>=arr[i];j--)
        part[j]=part[j] | part[j-arr[i]]
if(part[sum])
   printf("\nsubset exists\n");
```



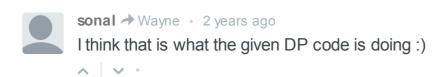


Wayne • 2 years ago Condn-sum should be divisible by 2;

We know the "sum" right !!! sum = sum of all the elements in array

Cant we use sum of subset problem (knapsack) to find out the subset which h easy because we know that the rest of elements sum is "sum/2",

/\* Paste your code here (You may **delete** these lines **if not** writing co





```
/* Paste your code here (You may delete these lines if
```



```
sindabad • 2 years ago
```

```
Sort the data in descending order
for(i=1 to n)
if(sum(set1) > sum(set2))
include the number in set2
else
if(sum(set2) > sum(set1))
include the number in set1
else
return 1;
retunr 0;
```



kartik → sindabad • 2 years ago this will not work for {5, 5, 4, 3, 3} ^ V ·



Venki • 2 years ago

How is different from fair work load problem?

http://topcoder.bgcoder.com/pr...

Reference: The Algorithm Design Manual by Skiena.



Ankit Gupta → Venki • 2 years ago

Hi, thanks for sharing the problem.

I can think of a recursive backtracking solution (do not know if it's right)

```
If workers == 0
    return 0
else
    calculate all possible partition(folders, N, sum/N) say new
    // sum is total count of the elements in folders and N is #
    foreach newfolders
        max = maximum of (sum(folders)-sum(newfolders), getMost
                and max
    return max
```

Can you hint at a solution?







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