

1. cluster

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1 def sum_rest(stations2, start_index2, sums2, sums_counter2):
2     if (start_index2 == len(stations2)):
3         return sums2, sums_counter2
4     else:
5         sums2.append(sums2[sums_counter2-1] + stations2[start_index2])
6         sums_counter2 += 1
7         return sum_rest(stations2, start_index2+1, sums2, sums_counter2)
8
9 def find_cluster_rec(stations, start_index, sums, sums_counter):
10     if (start_index == len(stations)):
11         return sums
12     else:
13         sums.append(stations[start_index])
14         sums_counter += 1
15         sums, sums_counter = sum_rest(stations, start_index+1, sums, sums_counter)
16         return find_cluster_rec(stations, start_index+1, sums, sums_counter)
17
18
19
20 def find_cluster2(stations):
21     sums = []
22     sums_counter = 0
23     sums, sums_counter = find_cluster_rec(stations, 0, sums, sums_counter)
24     return max(sums)
25

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In this method I start from start index and go until the end of the array. I sum the value with the previous value of the sum array and I add the current value from stations array. I increment the counter and I go until the end of the station array. This method takes $\theta(n)$ time. I will have recurrence relation at analysis part.

In this method I start from start index and go until the end of the array. Firstly I put the current integer value to the sum array. Then I increment the counter of the sum array. Then I start from one more index from the current index. It is explained in sum_rest method. Because I go until the end of array, I call this method n times. But in this method, sum_rest method takes $\theta(n)$ time, so overall complexity is $\theta(n^2)$

find_cluster_rec \Rightarrow base case if $i = n$
 \Rightarrow append to the end
 \Rightarrow sum_rest \Rightarrow to be calculated
 \Rightarrow return find_cluster_rec \Rightarrow $s+1 \Rightarrow T(n) = T(n-1) + 1$
 \Rightarrow sum_rest \Rightarrow base case \Rightarrow if $k = n$
 \Rightarrow append to the end \Rightarrow $\theta(n)$
 \Rightarrow return sum_rest \Rightarrow $(-s+1) \Rightarrow T(n) = T(n-1) + 1$
 Recurrence relation of the sum_rest
 $\Rightarrow T(n) = T(n-1) + 1$ $n=k+1$ $n=k+1$
 $T(n-1) = T(n-2) + 1$ $T(n-1) = T(n-1) + n$ $k=n-1$
 $T(n-2) = T(n-3) + 1$ $T(n) = T(n-1) + k$ $k=n-1$
 $T(n-3) = T(n-4) + 1$ $T(n) = T(n-1) + n-1$
 $T(n-4) = T(n-5) + 1$ $T(n) = T(n-1) + n-2$
 $T(n-5) = T(n-6) + 1$ $T(n) = T(n-1) + n-3$
 $T(n-6) = T(n-7) + 1$ $T(n) = T(n-1) + n-4$
 $T(n-7) = T(n-8) + 1$ $T(n) = T(n-1) + n-5$
 $T(n-8) = T(n-9) + 1$ $T(n) = T(n-1) + n-6$
 $T(n-9) = T(n-10) + 1$ $T(n) = T(n-1) + n-7$
 $T(n-10) = T(n-11) + 1$ $T(n) = T(n-1) + n-8$
 $T(n-11) = T(n-12) + 1$ $T(n) = T(n-1) + n-9$
 $T(n-12) = T(n-13) + 1$ $T(n) = T(n-1) + n-10$
 $T(n-13) = T(n-14) + 1$ $T(n) = T(n-1) + n-11$
 $T(n-14) = T(n-15) + 1$ $T(n) = T(n-1) + n-12$
 $T(n-15) = T(n-16) + 1$ $T(n) = T(n-1) + n-13$
 $T(n-16) = T(n-17) + 1$ $T(n) = T(n-1) + n-14$
 $T(n-17) = T(n-18) + 1$ $T(n) = T(n-1) + n-15$
 $T(n-18) = T(n-19) + 1$ $T(n) = T(n-1) + n-16$
 $T(n-19) = T(n-20) + 1$ $T(n) = T(n-1) + n-17$
 $T(n-20) = T(n-21) + 1$ $T(n) = T(n-1) + n-18$
 $T(n-21) = T(n-22) + 1$ $T(n) = T(n-1) + n-19$
 $T(n-22) = T(n-23) + 1$ $T(n) = T(n-1) + n-20$
 $T(n-23) = T(n-24) + 1$ $T(n) = T(n-1) + n-21$
 $T(n-24) = T(n-25) + 1$ $T(n) = T(n-1) + n-22$
 $T(n-25) = T(n-26) + 1$ $T(n) = T(n-1) + n-23$
 $T(n-26) = T(n-27) + 1$ $T(n) = T(n-1) + n-24$
 $T(n-27) = T(n-28) + 1$ $T(n) = T(n-1) + n-25$
 $T(n-28) = T(n-29) + 1$ $T(n) = T(n-1) + n-26$
 $T(n-29) = T(n-30) + 1$ $T(n) = T(n-1) + n-27$
 $T(n-30) = T(n-31) + 1$ $T(n) = T(n-1) + n-28$
 $T(n-31) = T(n-32) + 1$ $T(n) = T(n-1) + n-29$
 $T(n-32) = T(n-33) + 1$ $T(n) = T(n-1) + n-30$
 $T(n-33) = T(n-34) + 1$ $T(n) = T(n-1) + n-31$
 $T(n-34) = T(n-35) + 1$ $T(n) = T(n-1) + n-32$
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 $T(n-41) = T(n-42) + 1$ $T(n) = T(n-1) + n-39$
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 $T(n-43) = T(n-44) + 1$ $T(n) = T(n-1) + n-41$
 $T(n-44) = T(n-45) + 1$ $T(n) = T(n-1) + n-42$
 $T(n-45) = T(n-46) + 1$ $T(n) = T(n-1) + n-43$
 $T(n-46) = T(n-47) + 1$ $T(n) = T(n-1) + n-44$
 $T(n-47) = T(n-48) + 1$ $T(n) = T(n-1) + n-45$
 $T(n-48) = T(n-49) + 1$ $T(n) = T(n-1) + n-46$
 $T(n-49) = T(n-50) + 1$ $T(n) = T(n-1) + n-47$
 $T(n-50) = T(n-51) + 1$ $T(n) = T(n-1) + n-48$
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 $T(n-106) = T(n-107) + 1$ $T(n) = T(n-1) + n-104$
 $T(n-107) = T(n-108) + 1$ $T(n) = T(n-1) + n-105$
 $T(n-108) = T(n-109) + 1$ $T(n) = T(n-1) + n-106$
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 $T(n-110) = T(n-111) + 1$ $T(n) = T(n-1) + n-108$
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 $T(n-196) = T(n-197) + 1$ $T(n) = T(n-1) + n-194$
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 $T(n-198) = T(n-199) + 1$ $T(n) = T(n-1) + n-196$
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 $T(n-201) = T(n-202) + 1$ $T(n) = T(n-1) + n-199$
 $T(n-202) = T(n-203) + 1$ $T(n) = T(n-1) + n-200$
 $T(n-203) = T(n-204) + 1$ $T(n) = T(n-1) + n-201$
 $T(n-204) = T(n-205) + 1$ $T(n) = T(n-1) + n-202$
 $T(n-205) = T(n-206) + 1$ $T(n) = T(n-1) + n-203$
 $T(n-206) = T(n-207) + 1$ $T(n) = T(n-1) + n-204$
 $T(n-207) = T(n-208) + 1$ $T(n) = T(n-1) + n-205$
 $T(n-208) = T(n-209) + 1$ $T(n) = T(n-1) + n-206$
 $T(n-209) = T(n-210) + 1$ $T(n) = T(n-1) + n-207$
 $T(n-210) = T(n-211) + 1$ $T(n) = T(n-1) + n-208$
 $T(n-211) = T(n-212) + 1$ $T(n) = T(n-1) + n-209$
 $T(n-212) = T(n-213) + 1$ $T(n) = T(n-1) + n-210$
 $T(n-213) = T(n-214) + 1$ $T(n) = T(n-1) + n-211$
 $T(n-214) = T(n-215) + 1$ $T(n) = T(n-1) + n-212$
 $T(n-215) = T(n-216) + 1$ $T(n) = T(n-1) + n-213$
 $T(n-216) = T(n-217) + 1$ $T(n) = T(n-1) + n-214$
 $T(n-217) = T(n-218) + 1$ $T(n) = T(n-1) + n-215$
 $T(n-218) = T(n-219) + 1$ $T(n) = T(n-1) + n-216$
 $T(n-219) = T(n-220) + 1$ $T(n) = T(n-1) + n-217$
 $T(n-220) = T(n-221) + 1$ $T(n) = T(n-1) + n-218$
 $T(n-221) = T(n-222) + 1$ $T(n) = T(n-1) + n-219$
 $T(n-222) = T(n-223) + 1$ $T(n) = T(n-1) + n-220$
 $T(n-223) = T(n-224) + 1$ $T(n) = T(n-1) + n-221$
 $T(n-224) = T(n-225) + 1$ $T(n) = T(n-1) + n-222$
 $T(n-225) = T(n-226) + 1$ $T(n) = T(n-1) + n-223$
 $T(n-226) = T(n-227) + 1$ $T(n) = T(n-1) + n-224$
 $T(n-227) = T(n-228) + 1$ $T(n) = T(n-1) + n-225$
 $T(n-228) = T(n-229) + 1$ $T(n) = T(n-1) + n-226$
 $T(n-229) = T(n-230) + 1$ $T(n) = T(n-1) + n-227$
 $T(n-230) = T(n-231) + 1$ $T(n) = T(n-1) + n-228$
 $T(n-231) = T(n-232) + 1$ $T(n) = T(n-1) + n-229$
 $T(n-232) = T(n-233) + 1$ $T(n) = T(n-1) + n-230$
 $T(n-233) = T(n-234) + 1$ $T(n) = T(n-1) + n-231$
 $T(n-234) = T(n-235) + 1$ $T(n) = T(n-1) + n-232$
 $T(n-235) = T(n-236) + 1$ $T(n) = T(n-1) + n-233$
 $T(n-236) = T(n-237) + 1$ $T(n) = T(n-1) + n-234$
 $T(n-237) = T(n-238) + 1$ $T(n) = T(n-1) + n-235$
 $T(n-238) = T(n-239) + 1$ $T(n) = T(n-1) + n-236$
 $T(n-239) = T(n-240) + 1$ $T(n) = T(n-1) + n-237$
 $T(n-240) = T(n-241) + 1$ $T(n) = T(n-1) + n-238$
 $T(n-241) = T(n-242) + 1$ $T(n) = T(n-1) + n-239$
 $T(n-242) = T(n-243) + 1$ $T(n) = T(n-1) + n-240$
 $T(n-243) = T(n-244) + 1$ $T(n) = T(n-1) + n-241$
 $T(n-244) = T(n-245) + 1$ $T(n) = T(n-1) + n-242$
 $T(n-245) = T(n-246) + 1$ $T(n) = T(n-1) + n-243$
 $T(n-246) = T(n-247) + 1$ $T(n) = T(n-1) + n-244$
 $T(n-247) = T(n-248) + 1$ $T(n) = T(n-1) + n-245$
 $T(n-248) = T(n-249) + 1$ $T(n) = T(n-1) + n-246$
 $T(n-249) = T(n-250) + 1$ $T(n) = T(n-1) + n-247$
 $T(n-250) = T(n-251) + 1$ $T(n) = T(n-1) + n-248$
 $T(n-251) = T(n-252) + 1$ $T(n) = T(n-1) + n-249$
 $T(n-252) = T(n-253) + 1$ $T(n) = T(n-1) + n-250$
 $T(n-253) = T(n-254) + 1$ $T(n) = T(n-1) + n-251$
 $T(n-254) = T(n-255) + 1$ $T(n) = T(n-1) + n-252$
 $T(n-255) = T(n$

2. candy

```

3
4 def getmaxobtainable(price,length):
5     values = []
6     for i in range(length+1):
7         values.append(0)
8
9     values=getmaxobtainable_rec(price,length,1,INT_MIN_VALUE,values)
10    return values[length]
11
12 def determine_max(price,start_index,end_index,max_val,values):
13     if(start_index==end_index):
14         return max_val
15     else:
16         max_val = max(max_val, price[start_index] + values[end_index - start_index - 1])
17         return determine_max(price,start_index+1,end_index,max_val,values)
18
19 def getmaxobtainable_rec(price,length,start_index,max_val,values):
20     if(start_index==length+1):
21         return values
22     else:
23         max_val=INT_MIN_VALUE
24         max_val=determine_max(price,0,start_index,max_val,values)
25         values[start_index]=max_val
26         return getmaxobtainable_rec(price,length,start_index+1,max_val,values)
27

```

Firstly I take the prices of the candies. Then I fill the hold array with zeros because at each iteration I will have a maximum value. In recursive getmaxobtainable method I take price, start index, maxvalue, and values. If we reached the end of the array, we return the current hold array. Otherwise at each iteration of the second recursive function(determine max) we partitonate the value. For instance, if price[start] index is 4, We start from 1 and 3 then continue 2 and 2. We are doing the same operation to the all of the values of the price array.

$$T(n)=T(n-1)+\theta(n)$$

It is same as first question. Complexity becomes $\theta(n^2)$

Test Outputs:

```

[1, 5, 8, 9, 10, 17, 17, 20]
Maximum Obtainable Value is 22
[1, 5, 8, 9, 10]
Maximum Obtainable Value is 13

```

getmax obtainable \Rightarrow filling with 0 $\Rightarrow \sum_{i=0}^n 1 = n$
 getmax obtainable_rec \Rightarrow
 determine_max \Rightarrow goes until end of array.
 $\sum_{i=0}^n 1 = n$ fixed-rec op = constant time
 Determine_max is called. It has $\theta(n)$ complexity
 This function goes until end of array. So
 overall comp is $\sum_{i=0}^n n = n^2 \in \theta(n^2)$

3. cheese

```

1 def getMaxValue(weights, prices, capacity):
2     values = []
3     for i in range(len(weights)):
4         values.append([prices[i]/weights[i], weights[i], prices[i]])
5
6     values.sort(reverse=True)
7
8     totalValue = 0
9     for i in values:
10        currentWeight = int(i[1])
11        currentPrice = int(i[2])
12        if capacity - currentWeight >= 0:
13            capacity -= currentWeight
14            totalValue += currentPrice
15        else:
16            fraction = capacity / currentWeight
17            totalValue += currentPrice * fraction
18            capacity = int(capacity - (currentWeight * fraction))
19            if(capacity<=0):
20                break
21    return totalValue

```

At this function, I take weights array, prices array and capacity of the box. Then I create an array that holds the price/weight ratio of the cheese, weight of the cheese, price of the cheese. Then I sort the entire list depend on the price/weight ratio. Because the one that have most price/weight ratio should be put firstly. In the for loop, I take the current weight and current price of the cheese. Then I check the capacity if full or not. If we have enough capacity, then we put the entire cheese. If there is not enough capacity, we put a portion of the the cheese. We take fraction of the remained capacity. Then we put the cheese portion. At each put, we add price to get entire price of the box

Second for loop iterates through n element so worst case is $\theta(n)$. But before this we have sorting algorithm which has larger and $O(n \log n)$ complexity, Overall complexity is $O(n \log n)$

Test Outputs:

$\sum_{i=0}^{n-1} 1 = n \Rightarrow$ appending operation $\theta(n)$
 Sorting op = merge sort $n \log n$ $\theta(n \log n)$
 worst case $\sum_{i=0}^{n-1} 1 = n$ if capacity runs out it could be here less complexity
 But capacity is constant value. We don't need to take into account.
 Overall complexity is $\theta(n \log n)$

```
[10, 40, 20, 30]
[60, 40, 100, 120]
Maximum value = 240.0
[10, 40, 20, 30]
[60, 40, 100, 120]
Maximum value = 230.0
```

4. Courses

```

1 def maxcourse(all_courses, n):
2     max_counter = 1
3     cur_course = 0
4     for i in range(n):
5         if (all_courses[cur_course][1] <= all_courses[i][0]):
6             cur_course = i
7             max_counter += 1
8     return max_counter
9
10 start_time = [1, 3, 0, 5, 8, 5]
11 finish_time = [2, 4, 6, 7, 9, 9]
12 courses = []
13 for i in range(len(start_time)):
14     courses.append([start_time[i], finish_time[i]])
15 print(courses)
16 print(start_time)
17 print(finish_time)
18 print("Max number of course:", maxcourse(courses, len(start_time)))
19 print("-----")
20

```

I start from first course and look for the next course is overlapping or not, then I take it and incremented the counter

Test Outputs:

```

[[1, 2], [3, 4], [0, 6], [5, 7], [8, 9], [5, 9]]
[1, 3, 0, 5, 8, 5]
[2, 4, 6, 7, 9, 9]
Max number of course: 4
-----

```

$\sum_{i=0}^{n-1} 1 = n \Rightarrow T(n) = \theta(n)$
 $i=0$