

Homework2 for EECS 340

Yu Mi,yxm319

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1 Give a recursive algorithm to find the average (mean) value of an array of 2^k decimal numbers, where $k \in \mathbb{N}$.

Answer: The proposed algorithm is as follow:

Algorithm A1: Average(L)

Data: A list of 2^k decimal numbers L .

Result: The average of all the numbers in L .

if $L.length() = 0$ **then**

return $L[0]$

else

$length \leftarrow L.length()$

return $0.5 \times (\text{Average}(L[0, length/2 - 1]) + \text{Average}(L[length/2, length]))$

end if

2 R-12.6

Question: Suppose we are given a set of telescope observation requests, specified by triples, of (s_i, f_i, b_i) , defining the start times, finish times, and benefits of each observation request as

$$L = (1, 2, 5), (1, 3, 4), (2, 4, 7), (3, 5, 2), (1, 6, 3), (4, 7, 5), (6, 8, 7), (7, 9, 4)$$

Solve the telescope scheduling problem for this set of observation requests.

Answer: The time of scheduling can be shown in Fig.1, the number in the bar means the value of such task.

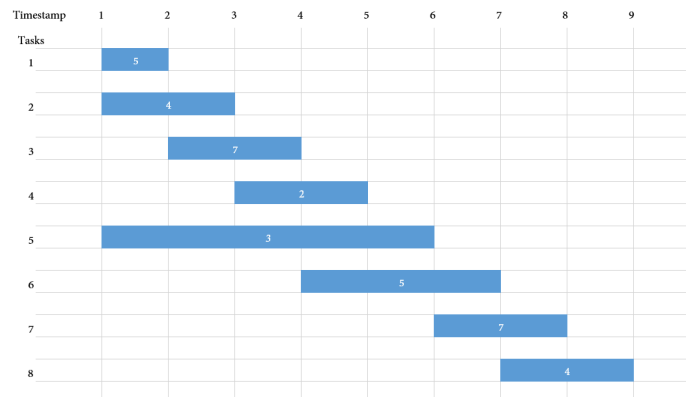


Figure 1: Time of tasks

Based on what we have discussed on class, we can have a table of B_i which stands for the maximum benefit that can be achieved with the first i requests in the task list.

To fill this table, we follow the algorithm as follow:

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 $B[0] \leftarrow 0$ 
for  $i = 1$  to  $n$  do
     $B[i] \leftarrow \max(B[i-1], B[P[i]] + b_i)$ 
end for

```

Here the $P[i]$ stands for the array which gives the predecessor index for each request i , and b_i means the value of each single task. The table is shown as Table 1.

Table 1: B_i values

i	0	1	2	3	4	5	6	7	8
B_i	0	5	4	12	6	3	17	13	21

As we can see, the highest value is B_8 , which includes task 1,3,6,8 that we should select. The corresponding triples are (1, 2, 5), (2, 4, 7), (4, 7, 5), (7, 9, 4).

3 Implement *det-bogoSort* in pseudocode using recursion

Answer: This algorithm is described as follows:

Algorithm BogoSort(S, L, L_{temp})

Data: Input list L , as is described in the question, an initially empty set of lists S , and an initially empty list L_{temp}

Result: A sorted copy of L

```

if  $size(L) = 0$  then
     $flag \leftarrow true$ 
    for  $i \leftarrow 1$  to  $size(L_{temp}) - 1$  do
        if  $L_{temp}[i-1] > L_{temp}[i]$  then
             $flag \leftarrow false$ 
            break
        end if
    end for
    if  $flag = true$  then
        return  $L_{temp}$ 
    end if
else
    for  $i \leftarrow 0$  to  $size(L) - 1$  do
         $L_{temp}.append(L[i])$ 
         $L.remove(i)$ 
        BogoSort( $S, L, L_{temp}$ )
    end for
end if

```

NOTE: in the operations of lists, $L_{temp}.append(L[i])$ means to append the element $L[i]$ at the end of list L_{temp} . And $L.remove(i)$ means to remove the i th element in list L .

4 Write pseudo-code for a new recursive function *moving-average*

Answer: The algorithm is shown as follows:

Algorithm moving-average(S, t_{start}, t_{end})

Data: Stock-price time series data S , a start time t_{start} , and a ending time t_{end} .

Result: The average stock price from t_{start} through t_{end} .

```

 $i \leftarrow 0$ 
if  $t_{start} = t_{end}$  then
    return 0
end if
if  $t_{start} = t_{end} - 1$  then
    return  $S[t_{start}]$ 
end if
for  $i \leftarrow t_{end} - 1$  to  $t_{start}$  do
    if  $t_{start} \% (i - t_{start}) = 0$  and  $((i - t_{start})$  is a power of 2) then
        return  $\frac{i - t_{start}}{t_{end} - t_{start}} \times \text{pow-of-two-average}(S, t_{start}, i) + \frac{t_{end} - i}{t_{end} - t_{start}} \times \text{moving-average}(S, i, t_{end})$ 
        break
    end if
end for
return 0

```

5 Write pseudo-code for a recursive function to compute $checker\text{-}sum(A)_{i,j}$ given the triple (A, i, j)

Answer: The algorithm is shown as follows:

Algorithm checker-sum(A, i, j)

Data: A matrix A , and index i and j

Result: The checkerboard sum of matrix A

```

if  $j > 1$  then
    return compute-row( $A, i, j$ ) - checker-sum( $A, i, j - 1$ )
else
    return compute-row( $A, i, j$ )
end if

```

Algorithm compute-row(A, i, j)

Data: A matrix A , and index i and j

Result: The checkerboard sum of row j in matrix A

```

if  $i > 1$  then
    return  $A(i, j)$  - compute-row( $A, i - 1, j$ )
else
    return  $A(i, j)$ 
end if

```

6 Read section 17.1 in the textbook and then solve the following problems

6.1 R-17.7

Question: Show that the CLINQUE problem is in NP

6.2 C-17.3

Question: Show that we can deterministically simulate in polynomial time any nondeterministic algorithm A that runs in polynomial time and makes at most $O(\log n)$ calls to the **choose** method, where n is the

size of the input to A .