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COMP3121 Assignment 4 – Question 3

3) We have been given a situation where for a total of N days at a resort, we are required to pick an activity out of three possible activities to do on that day, such that we want to get the maximum enjoyment out of the whole trip. We are also given restrictions such as we cannot do the same activity two days in a row and the same activity may have different enjoyment levels on different days.

Since we know which activities on which days will provide us with the greatest level of enjoyment, we need to find a way such that we can ascertain the potential combinations to get the greatest level of enjoyment from the entire trip (as we may not be able to pick an activity on a particular day as we already did it a day before or we do not do a particular activity for one day and instead do it another day as we have identified that foregoing the activity will ultimately result in the greatest enjoyment as an example).

What we can do is to calculate for each day $i \leq N$, and each activity a_j out of three possible activities, solving the problem of P(i, j) of finding the optimal activities up to day i, so that we do activity j on day i.

Since the enjoyment levels are already pre-determined, the approach we can take to achieve this by first defining our parameters – E(i, j) is the enjoyment we derive from activity j on a certain day (where j is one of three possible activities) and i is our day. For example, E(4, 2) refers to the enjoyment level of activity 2 on day 4. First, we need to do some pre-processing and sort the enjoyment levels of each activity j from day 1 to day n. Next, we need to define our subproblems. We can recognise that many of the recursive calls will be to do with calculating the next optimal enjoyment level for the other two activities (if we have picked one). Hence, our subproblems will be of the form of calculating the optimal activities to pick up to our current day, which will run in parallel as we are calculating it for the other activities as well. So, our base case if we have n = 1 would be to pick largest enjoyment level which would satisfy our algorithm. For the general cases, we would consider for i where 1 < i < N, we would have:

$$E_{opt}(i,j) = \max\{T_{opt} = \sum_{1}^{i} E_{opt}(i-1, j^*) : 1 \leq i \leq N, j^* = activities\ not\ current\ activity\}$$

Hence, if we get the optimal value for the previous days, we will be able to get the optimal value all the way to the current day.

We can simply fill in our table as for each day and activity as a result and if we need to go to the next day, we can refer to our table and look at our most recent previous filled day and go on from there. The overall time complexity will be $O(n^2)$ as a result as at each stage, we are calculating the optimal enjoyment for the activities in parallel and filling in the table.

End of Solution