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ĐẠI HỌC BÁCH KHOA HÀ NỘI

HANOI UNIVERSITY OF SCIENCE AND TECHNOLOGY

ONE LOVE. ONE FUTURE.

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Applied Algorithm Lab

Gold mining

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Gold mining

- Given n gold warehouse in a straight line
  - Warehouse i stores an amount of a_i and located at point i in the line
- **Objective:** Find a subset of warehouse with largest sum of amount
- **Constraint:** distance between 2 warehouses must be in $[L1, L2]$
- **Output:** The amount found
- **Example:**

Input	Output
6 2 3 3 5 9 6 7 4	19 explain: 3+9+7=19

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- **Idea to solve #1:** Backtracking and Branch and bound
  - List all ways to choose a subset of gold warehouse
    - For each case, check if 2 consecutive warehouse has distance in [L1, L2]
    - if all pair satisfy distance constraint, update the amount if needed
  - Complexity: O($2^n * n$).
  - Some BnB technique can be applied:
    - While considering the i warehouse, the next ware house must be in [i + L1, i + L2].
    - Apply BnB for objective function
    - still can not pass full testcases…

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- **Idea to solve #2:** Dynamic programming: Consider choosing warehoue i
  - Let F[i] be maximal amount available if we choose some warehouses from 1 to i-1 **and choose warehouse i.**
  - Base case: F[i] = a[i].
  - Formula:

$$\mathrm{F[i]} = max_{j\epsilon[i-L2,\, i-L1]}(a[i] + F[j]), \forall i\epsilon[L1, n).$$

  - return:

$$max_i F[i], \forall i \in [1, n].$$

  - Complexity: O(N^2).

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- **Idea to solve #3:** Dynamic programming with priority queue
  - Priority queue: a queue with order. The element are sorted in order of priority
  - Improve to idea #2:
    - An element in priority queue: (j, F[j]) with F[j] be the priority.
    - element with big F[j] will be in the front
    - Considering ware house i: add (i – L1, F[i – L1]) to the queue.
    - Remove the top element of queue if i – i.top > L2.
    - F[i] = a[i] + F.top.
  - Complexity: O(n*log(n)).

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- Idea to solve #2: Dynamic programming with dequeue
  - Dequeue: a combination of stack and queue -> element can be add or remove in both the back and front of dequeue
  - Operation: push_back(), push_front(), pop_back(), pop_front()
  - Improvement: Element in queue: (x, F[x]). Traverse F[i] in order.
    - Remove all element j that F[j] $\leq F[i - L1]$, then add F[i – L1] to the queue.
    - Delete the top element of the queue until top >= i – L2.
    - F[i] = F[top] + a[i].
  - Complexity: O(n).

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THANK YOU !