

## CS2040S: Data Structures and Algorithms

### Exercises/Optional Problems for Week 2

*For: February 10, 2020*

#### Problem 1. Kattis's Quest

Taken from: <https://open.kattis.com/problems/kattisquest>

Kattis the Cat enjoys clearing quests on her mobile game. Each quest has an energy consumption  $E$ , and gold reward  $G$ . However, as Kattis has become very busy lately with grading her student's problem sets, she does not have much spare time as before to keep clearing quests. As such, she has adopted a new 'greedy' strategy to clear her quests in each session as quickly as possible. With energy  $X$ :

For a session, she will do the following:

1. Find the largest energy quest from the current pool of quest which is smaller or equal to  $X$ . If there are multiple, then pick the one that also has the largest gold reward.
2. Clear the quest, removing it from current pool. Reduce energy  $X$  by  $E$  of the quest, and add up the gold reward  $G$  earned this session.
3. Repeat steps 1 and 2 with remaining amount of energy, until energy left becomes 0, or if there are no more quests to be cleared with remaining energy.

Your job is to make use of data structures to support the following functions:

- `void add(long energy, long value)` Given a a value quest with the specified energy and value, insert it into your data structure in  $O(\log n)$  time.
- `query(long remainingEnergy)` Implements the algorithm mentioned above and returns the total gold reward obtained in  $O(\log n)$  time.

For example, consider the following sequence:

1. add 8 10
2. add 3 25
3. add 5 6
4. query 7 (returns 6)
5. query 7 (returns 25)
6. add 1 9
7. add 2 13
8. query 20 (returns 32)
9. query 1 (returns 0)