

# Augmented Trees Problem Solving

The hint is, you will use the augmented trees to solve these problems.

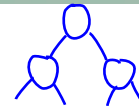
## Problem 1 Average Salary below Someone

A Company has a lot of employees. Let  $n$  is the number of employees and  $n$  is very big. Assuming that each employee has a unique name and unique amount of monthly salary.

For a certain employee, e.g. Amy, what is the *average monthly salary* of all employees who have salaries less than or equal to Amy?

go right &  $\frac{t}{w}$

Design a data structure that can store, modify and query in an efficient way.



## Problem 2 Cutting Queue

We know the queue data structure and imagine that we have an online system to queue for masks. And every item in the queue is a unique ID, e.g. The Singapore NRIC# or any passport numbers.

However, there is a new policy (and probably a bad one that will create a big loophole.) If a person A is already in the queue, we can allow one of his direct family member B to “cut queue”. Namely, we will insert B into the queue right after A.



Design a data structure that support the following operations for a queue

- **cutQueueAfter (A,B) :**
  - Insert B immediately after A
- **isAfter (A,B) :**
  - Is B after A in the total order? (not necessarily immediately after)

P2

Use a Rank Tree

If A has no right child, insert B as A's right child

Otherwise, insert B as the left child of A's successor

Then balanced the rank tree as usual

Solution 2:

no need to keep rank or weight. just walk up from A and B to find the lowest common ancestor, then decide which one come first

P1

P1a Augment the tree with the sum of the items

P1b Use the above and also augment with the weight and find the rank like the lecture

P1 Create another tree indexed by names and each node contains their salaries.

P1 If duplicated data, augment the tree of salaries with counts

Solution 1:

Find the ranks of A and B to compare

However, it is not a search tree. How do we locate the nodes of A and B in the first place?

Use another tree or Hash Table