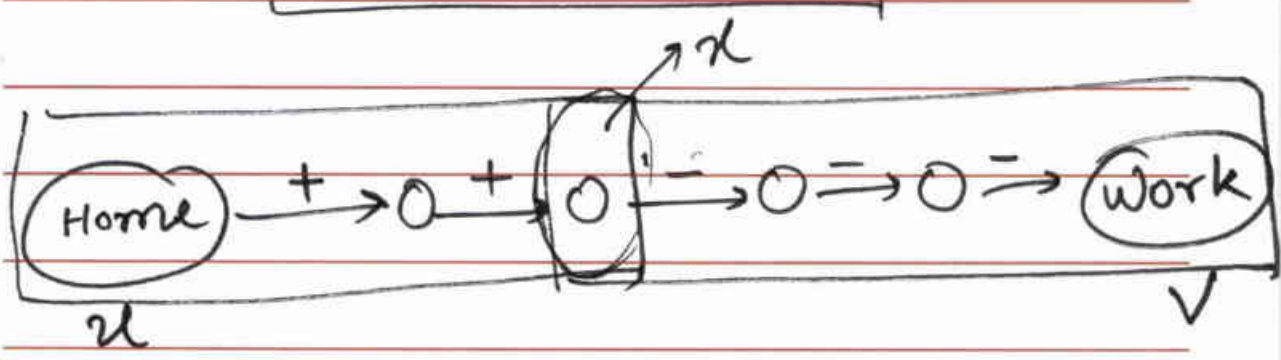
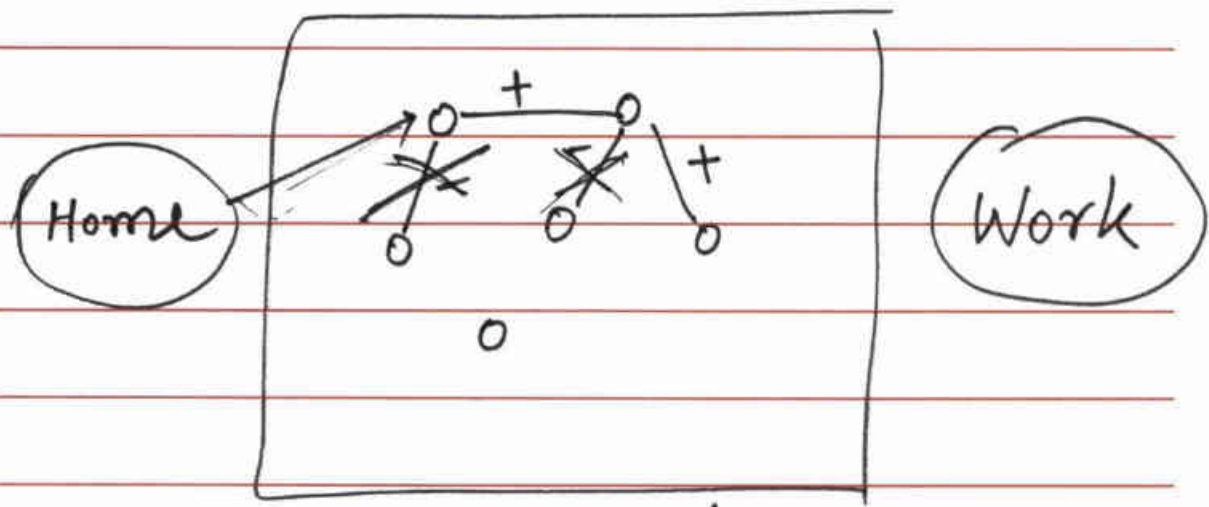
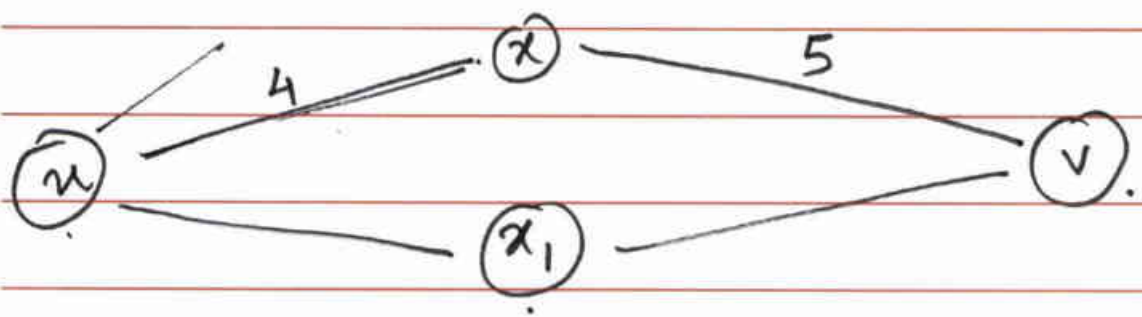


①



$$[d^+(u, x) + d^-(x, v)]$$



Find x s.t.

$$\left[d^+(u, x) + d^-(v, x) \right]$$

is minimized

$$\frac{d^+(u, x)}{d^-(v, x)} \quad \forall x$$

Iterate over x to find

$$\operatorname{argmin}_x \left[d^+(u, x) + d^-(v, x) \right]$$

$$|V| = k$$

Complexity

$$O(k + m)$$

$$O(k)$$

③

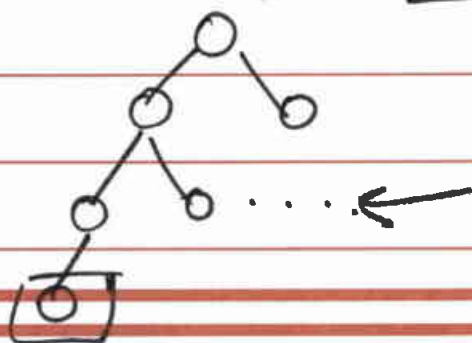
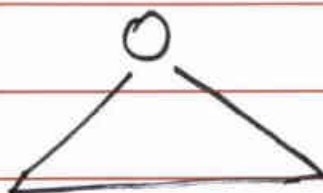
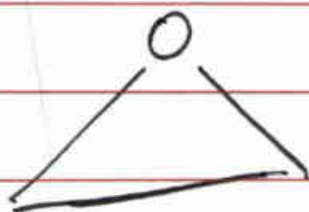
A

n_1

B

n_2

$n_1 + n_2 = n$



Not a heap

- ① Compare roots $\xrightarrow{\text{same}}$ DONE! $O(1)$
 - ② Extract the smaller min $O(\log n)$
 - ③ if empty \rightarrow No common element
- n

Complexity $O(n \log n)$

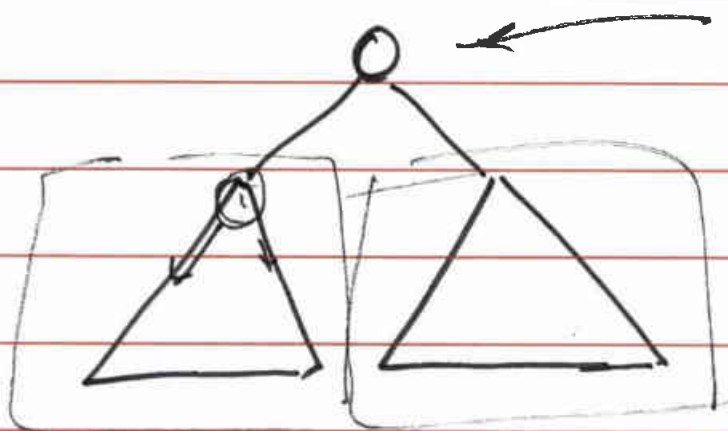
Given:

min-Heap

x

Output all elements $\leq x$

$O(k)$ time, where k is the no. of elements $\leq x$

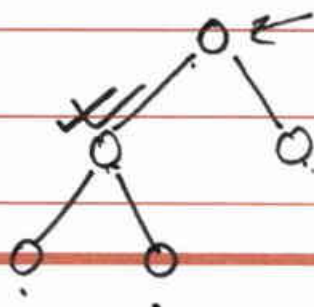


Is root $> x$
 yes
 terminate

1. Output the root

recurse on the subtree

$O(k)$



1 3