0	1	2	3	
	5	10	9	K
	q	z	a	V
X	✓	✓	✓	valid

K V

$5 \mapsto q$

$5 \% 4 = 1$

$10 \mapsto z$

$9 \mapsto a$

0	1	2	3	4	5
	1	7	3	13	
	q	a	z	b	
	✓	✓	✓	✓	

amortized worst-case

expected

worst-case

on average

over a series of calls

inserts	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
copies	0	0	2	0	4	0	0	0	8	0	0	0	0	0	0	0	16

average case

uniformly random / evenly weighted

best-case

		data	Universe
expected	worst-case	evil	indifferent
worst-case		evil	evil

Function EWC(n):

    i ← 0
    while i < n:
        j ← random #: either 0 or $\frac{n}{2}$
        if i = j

WC = O(n)

EWC = O(1)

Heaps

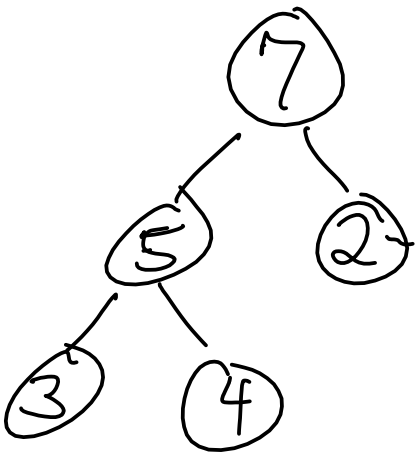
enqueue/dequeue: $O(\log n)$

complete

children $\leq$ parent

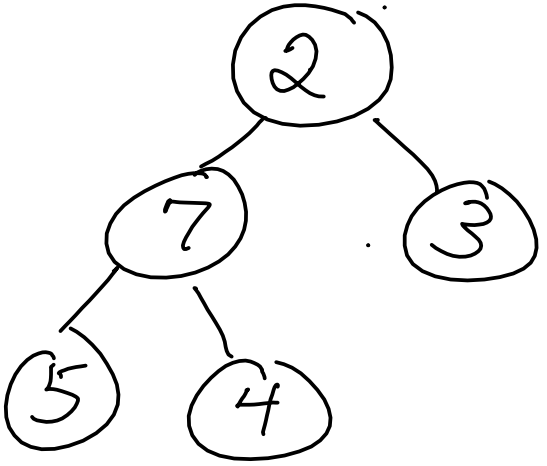
Heapify

7 5 2 3 4



heapify:
for each node from
bottom to top:
bubble down

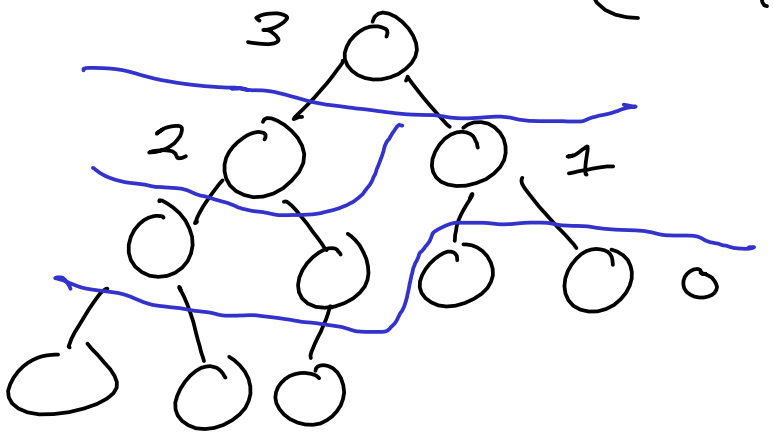
2 7 3 5 4

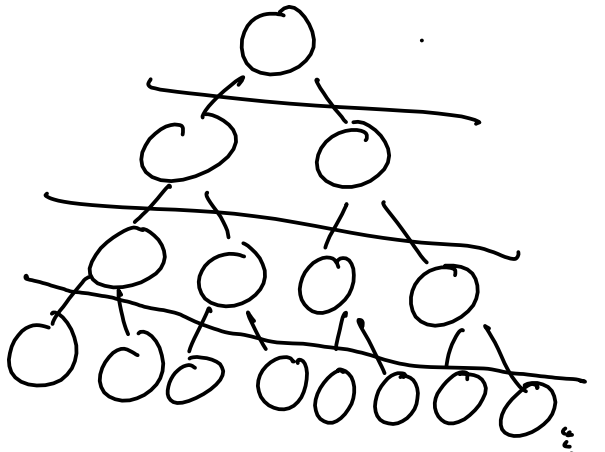


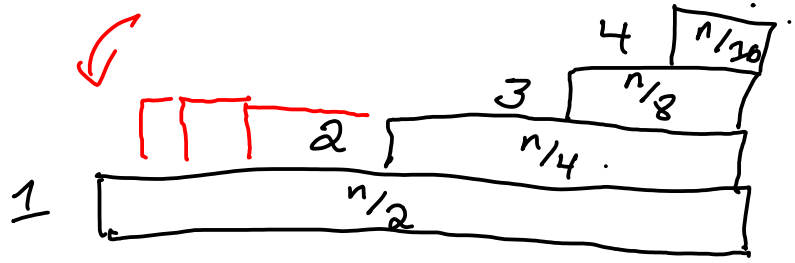
bd: $O(\log n)$

× each node: $O(n)$

$O(n \log n)$







$$8 \cdot 0 + 4 \cdot 1 + 2 \cdot 2 + 1 \cdot 3$$

$$\frac{n}{2} \cdot 0 + \frac{n}{4} \cdot 1 + \dots + 2 \cdot (\log_2 n - 1) + 1 \cdot \log_2 n$$

$$\sum_{i=0}^{\log_2 n} \frac{n}{2^{i+1}} \cdot i = \frac{n}{2} \cdot \sum_{i=0}^{\log_2 n} \frac{i}{2^i} < \frac{n}{2} \sum_{i=0}^{\infty} \frac{i}{2^i} = \frac{n}{2} \cdot 2 = n$$

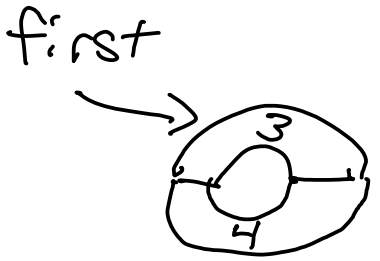
CycleList : ADT

T get(int index)

void insertAtHead(T)

T removeHead()

void rotateRight()



get(0) ⇒ 3

get(1) ⇒ 4

get(2) ⇒ 3