

RA I/O MODEL

EM. MODEL

RAM $\approx 10^{-9}$ SECS

BLOCKS $\frac{\text{READ}}{\text{WRITE}}$

5.4 K RPS $\rightarrow 10$ KOPS

≈ 7 K RPS 10^6

3 GHz CPU

≈ 1 GHz BUS MEMORY



10^{-3} SECS

BLOCKS $\approx 10^3$ Bytes

LATENCY LONG PERSISTENT TIME

DICTIONARY

- FLASHING

10^8 ITEMS

ITEMS

$$\frac{n}{B}$$

$h(k)$

INTERVAL TABLE

RAM

EXTERNAL CHAINING

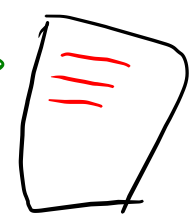


DISK BLOCK.

10^3 Bytes

10^2

B ITEMS PER BLOCK



EXPECTED NUMBER OF I/O OPS $O(1)$

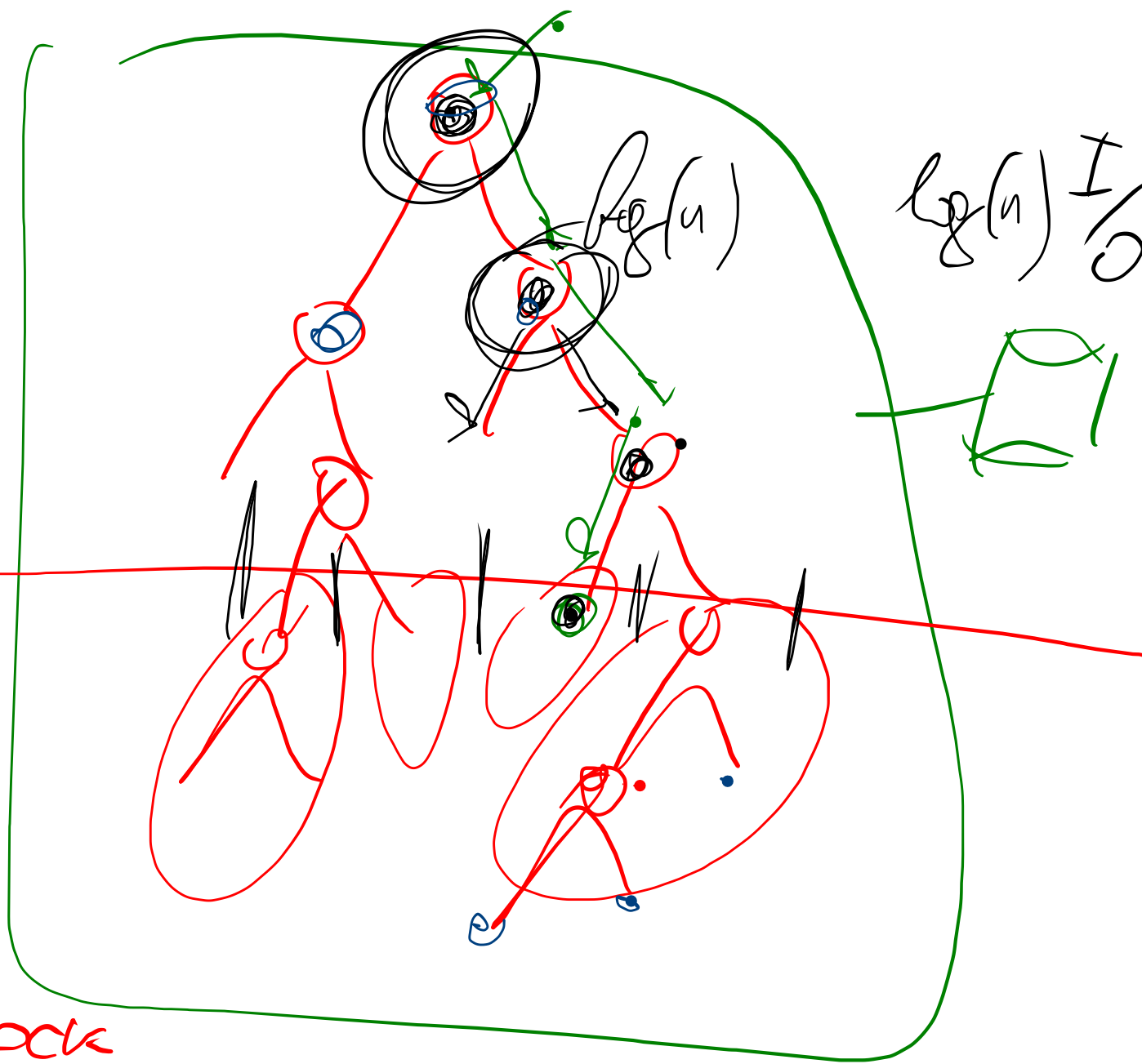
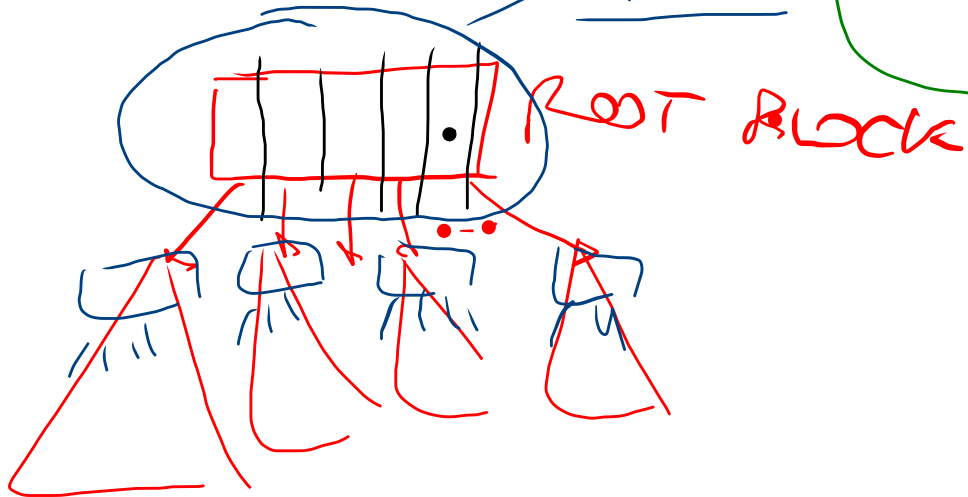
TREES

B ITEMS



B-TREE

DISK
BLOCK



$\lg(n) \frac{I}{O}$

B. TREE

K ITEMS IN EACH BLOCK

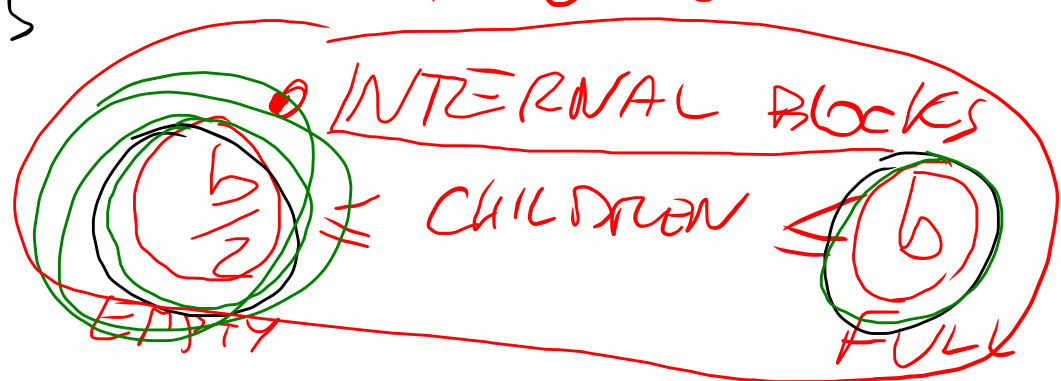
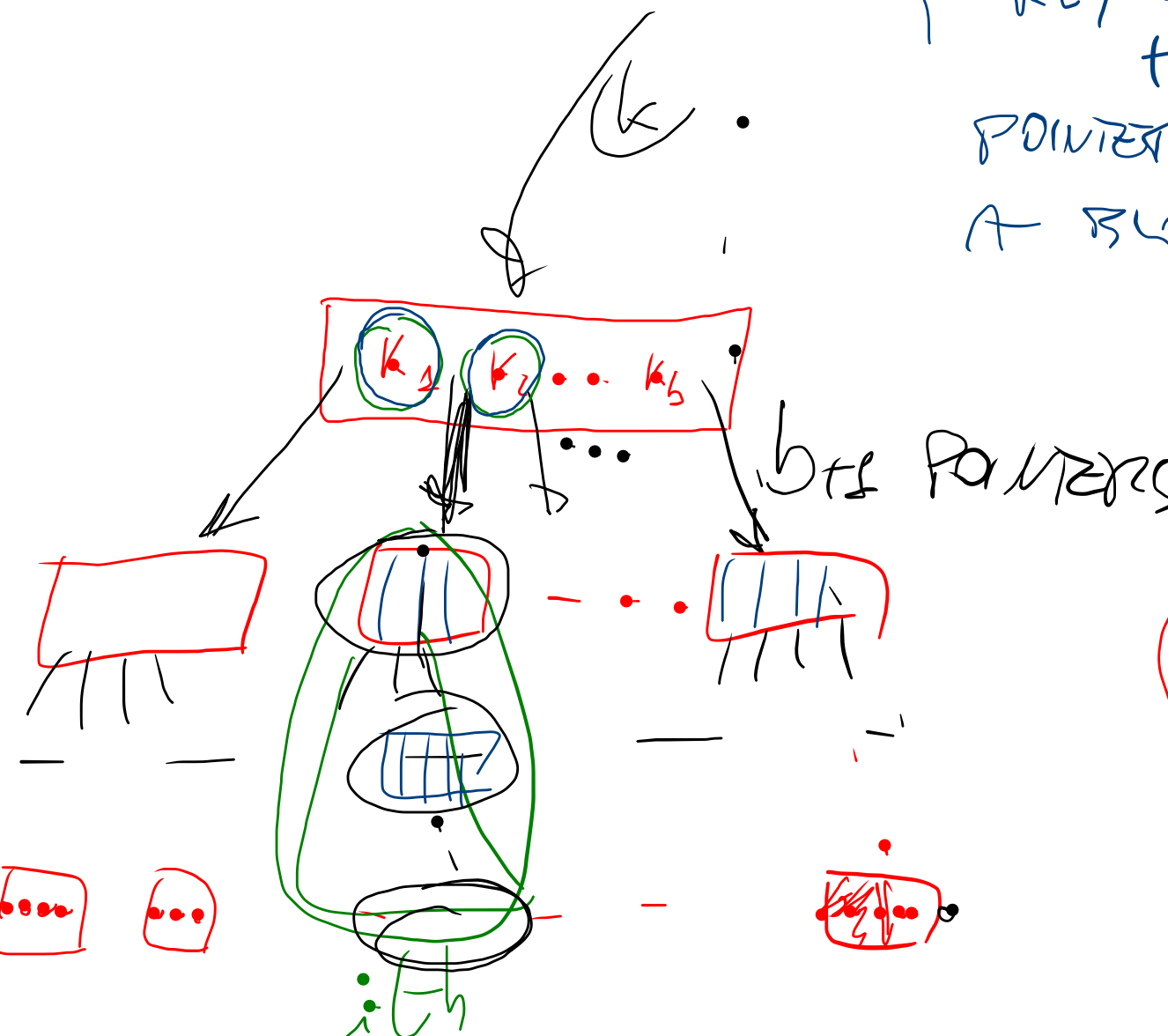
KEY VALUE
+
POINTER TO
A BLOCK

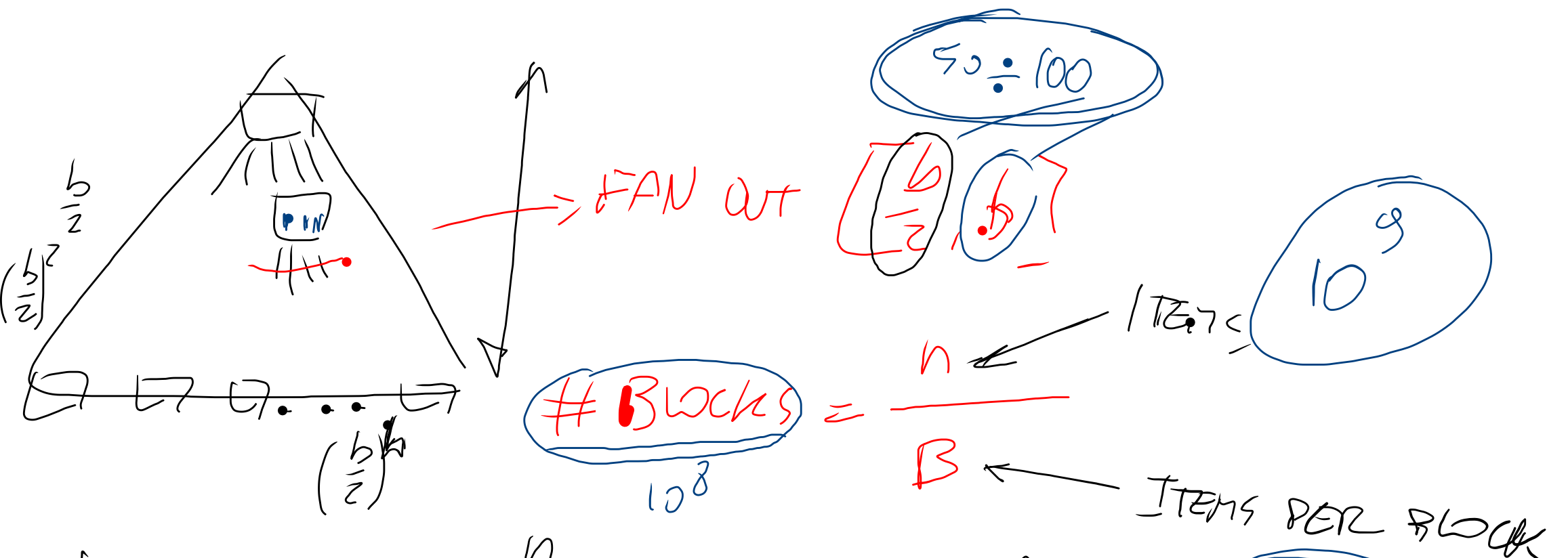
• LEAVES FULL
ALL $\geq 50\%$

• LEAVES IN
SAME LEVEL

• INTERNAL BLOCKS
CHILDREN \leq (b)

• ROOT
(2) \leq CHILD \leq (b)





HEIGHT: $\log_b \frac{n}{B} < \log_{\frac{b}{2}} \frac{n}{B}$

← FAN OUT

$\log_{50} 10^8 = 7$

$\log_{100} 10^8 = 4$

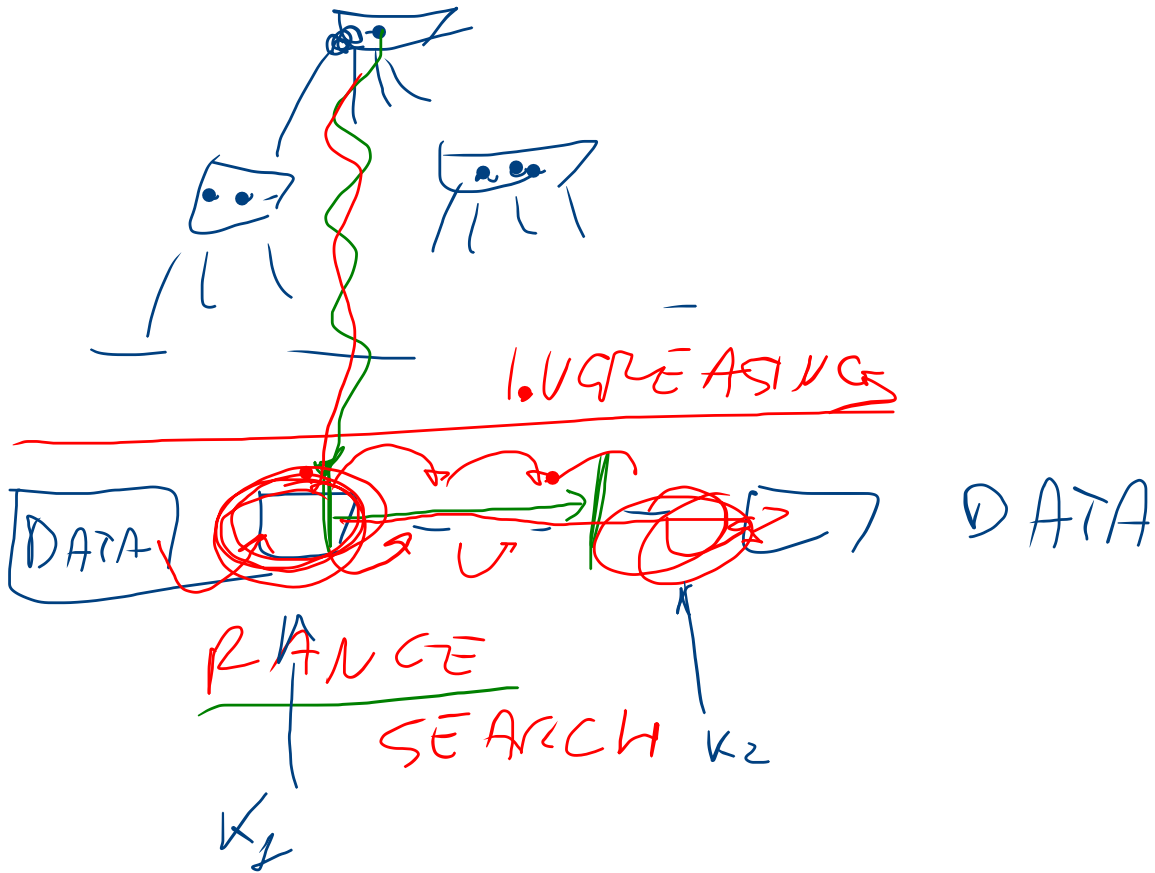
$100^4 = 10^8$

$\# \text{ I/Os}$

B-TREES : DATA AND KEYS IN INTERNAL BLOCKS

B*-TREES : DATA IN LEAVES + KEYS

ONLY KEYS IN INTERNAL NODES



RANGE SEARCH :
 $O(\log_{\frac{n}{B}})$ + RECORDS $\times 2$
+ 2

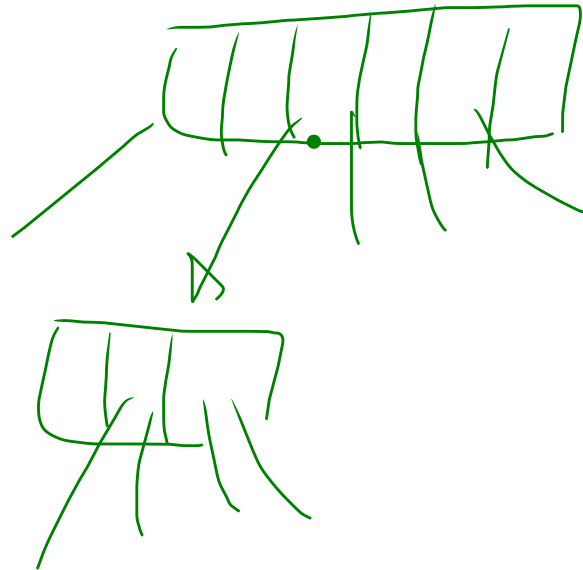
INSERTION

B^X TREE

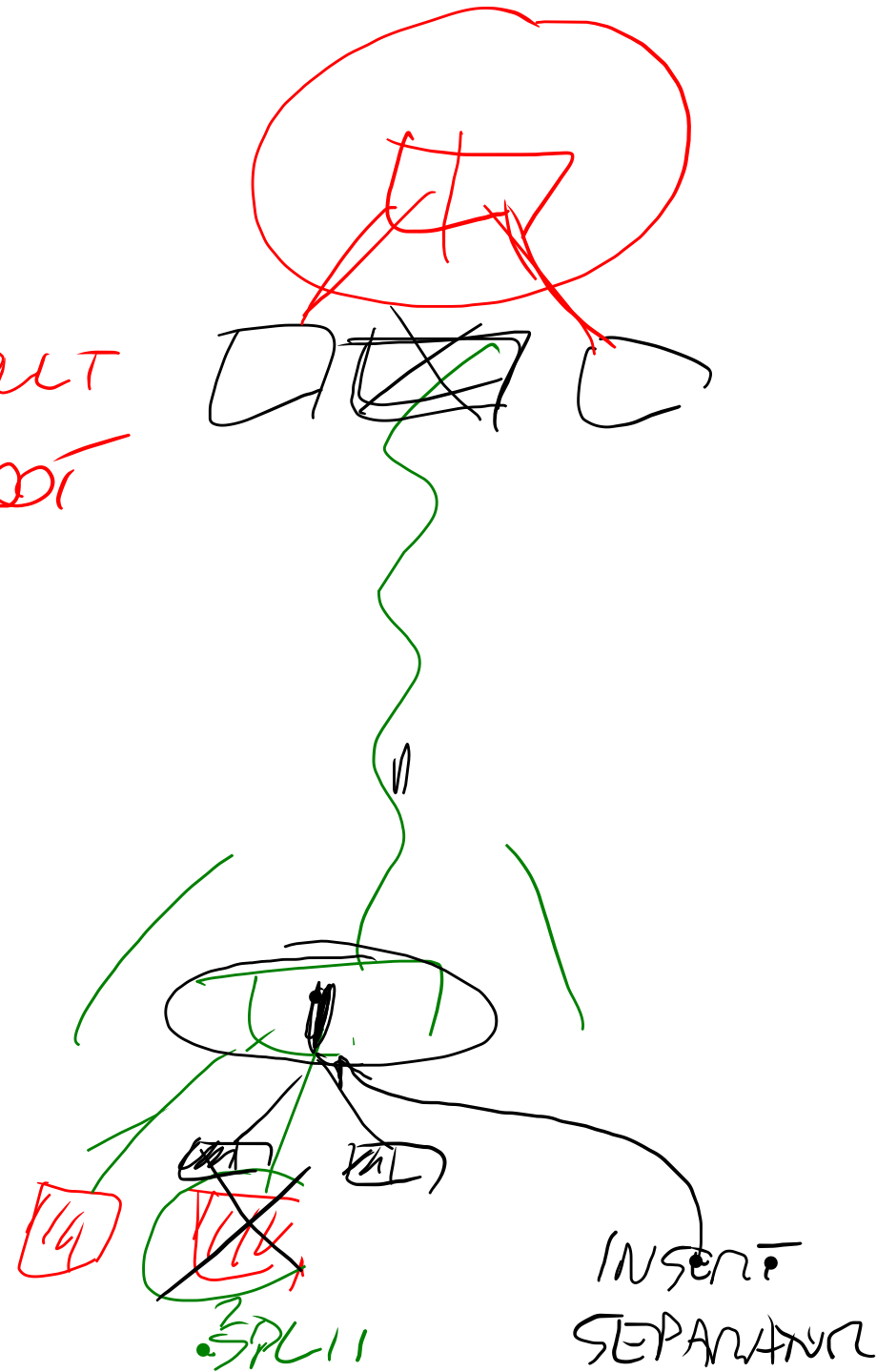
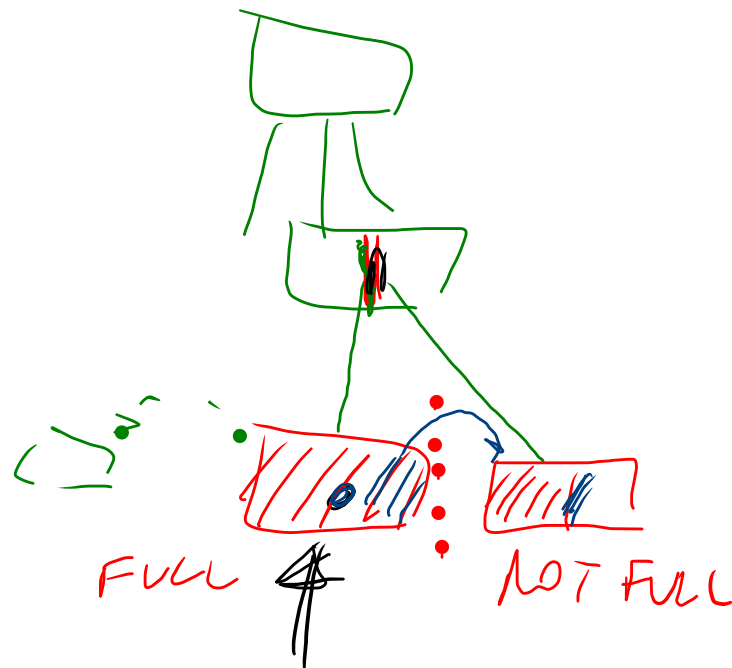
$\frac{1}{B}$

$\approx \alpha$ HEIGHT

$O(\log_{\frac{n}{B}})$



SPLIT ROOT

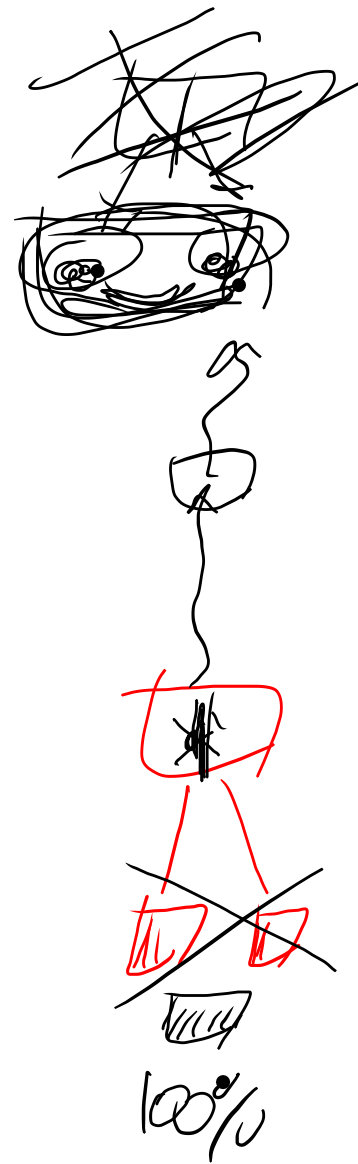
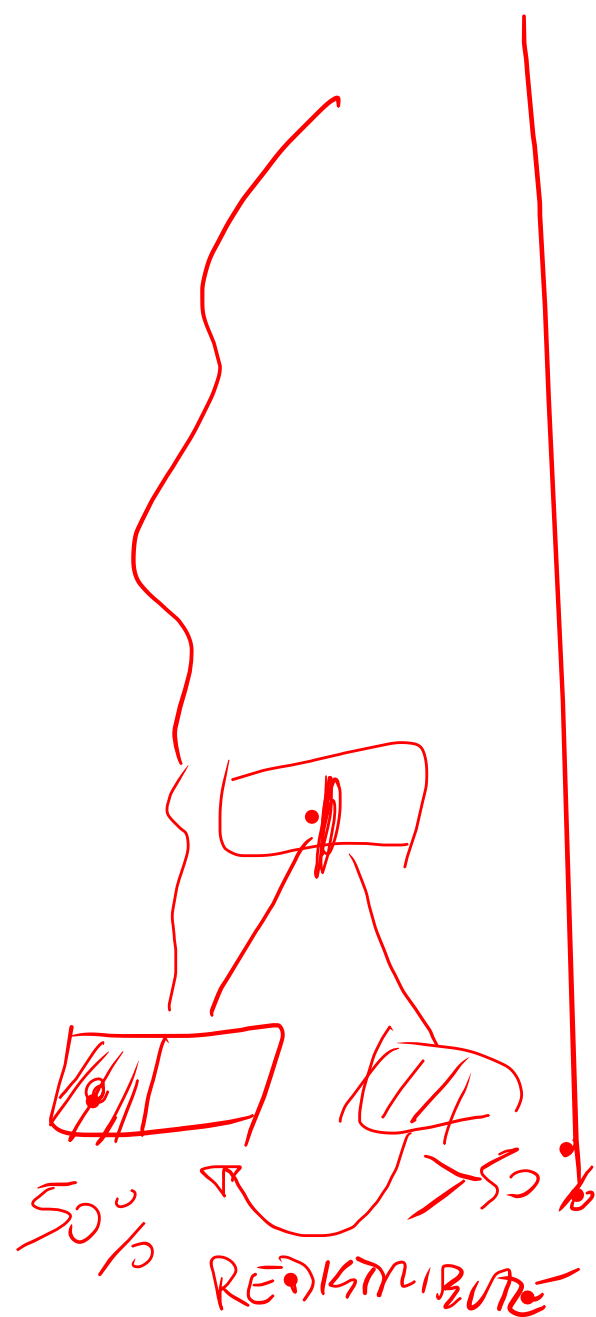
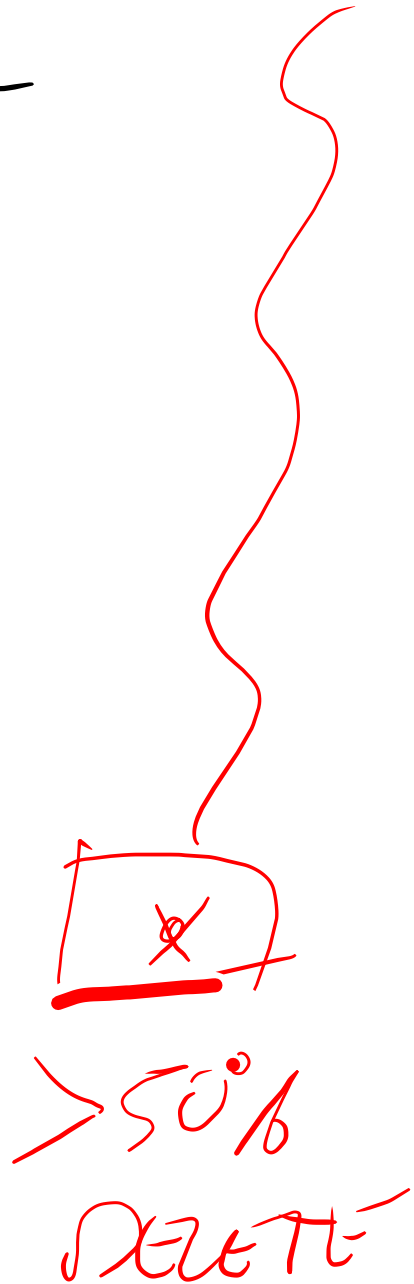


DELETION

CONSTANT

I/O

EACH
LEVEL



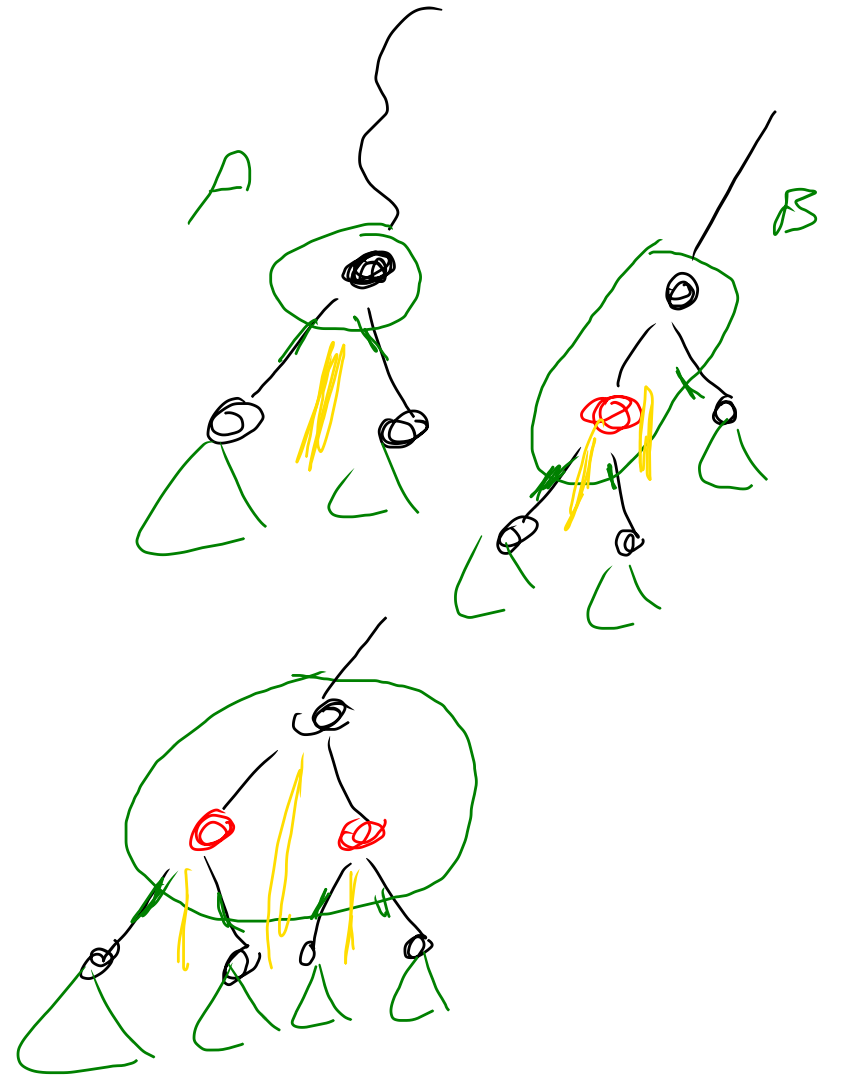
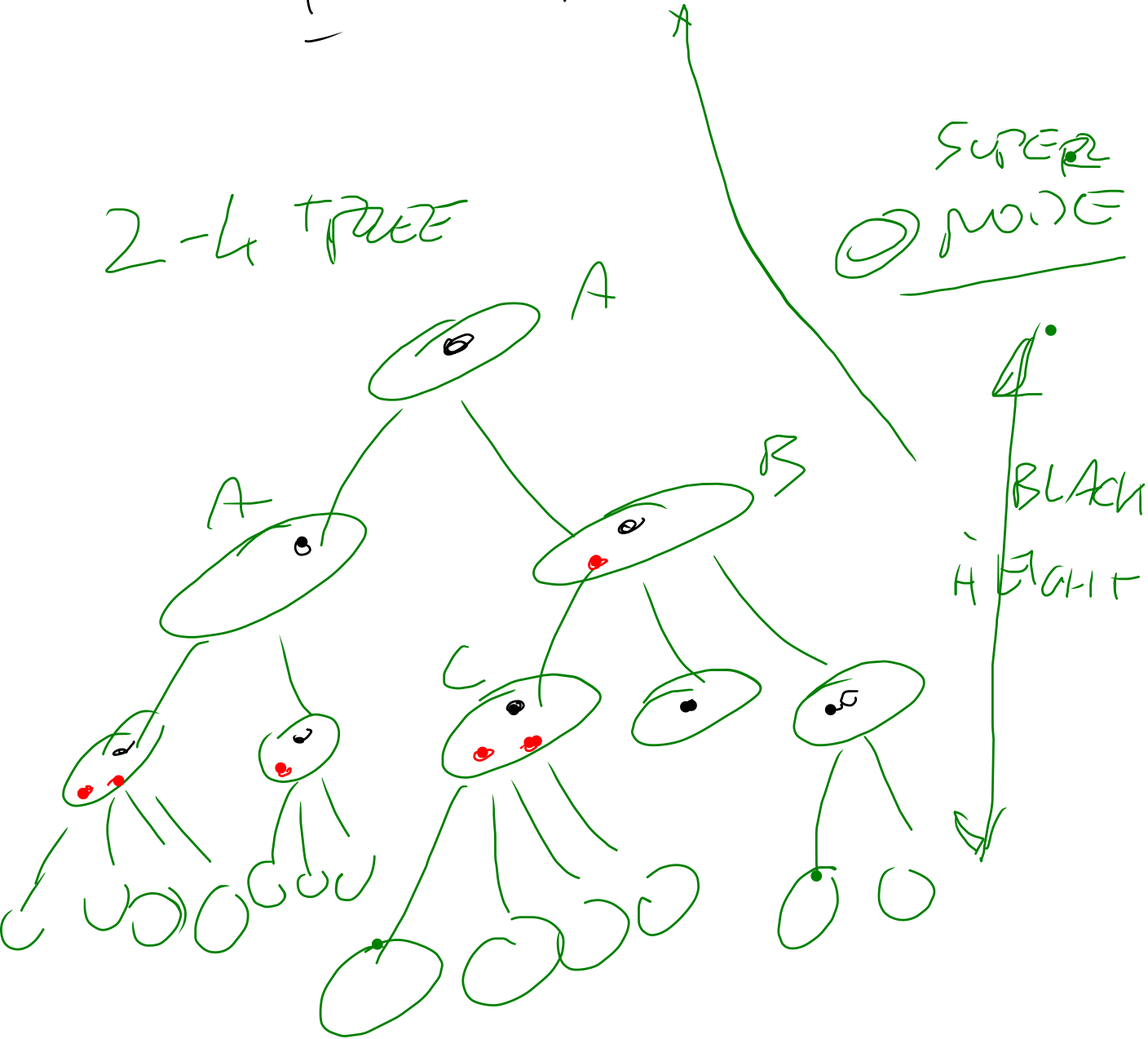
B-TREES

VS

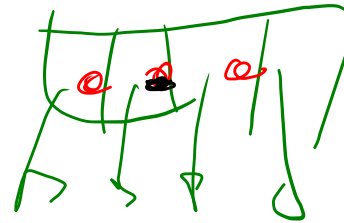
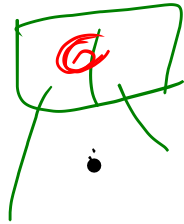
R B TREES

2-4 TREE

SUPER
NODE



2-4 TREE

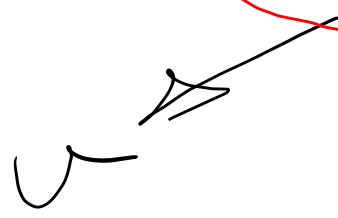


DICTIONARY

- INSERT (k, v)

- DELETE (k) ONLY MAX

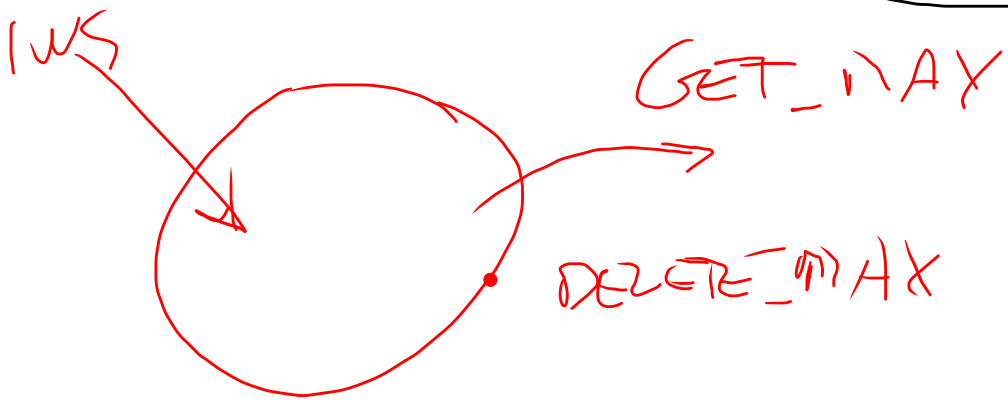
- SEARCH (k) ONLY MAX



A.D.T

PRIORITY

QUEUE

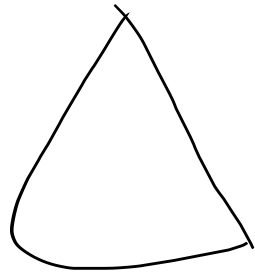


~~HASHING?~~
~~BST?~~

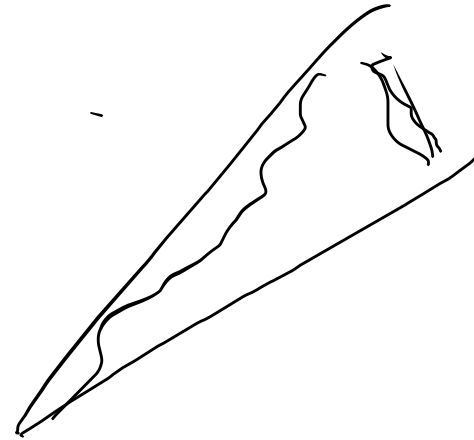
RANDOM

INS: $O(\log_2 n)$
MAX: $O(\log n)$
DEL_MAX: $O(\log n)$

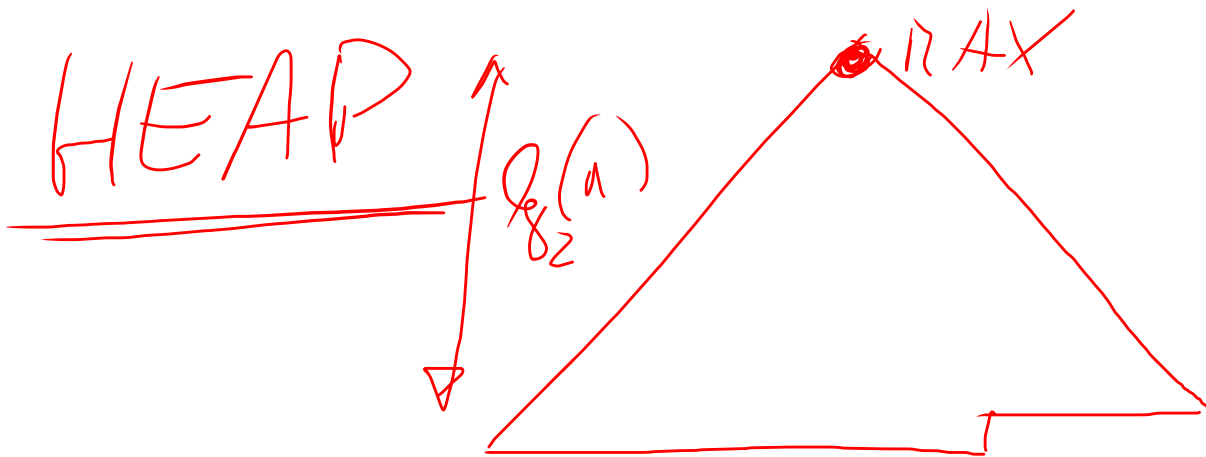
PRIORITY QUEUE BST



DEL



R.R. TREE $\Rightarrow O(\log(n))$



- INS $O(\log n)$
- DEL $O(\log n)$
- MAX $O(1)$