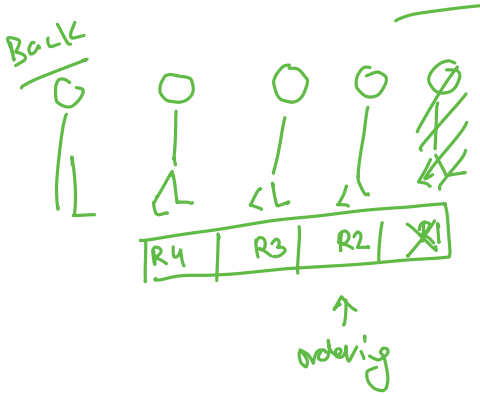
Data → Containers
Structures

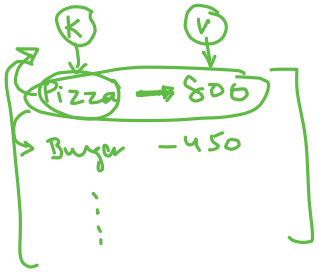
Stack Tree Heap Hashtable ....

Bank



Queue (FIFO)

Collection
- ⇒ ordered (ARRAY, Queue.....) — Arraylist
- ⇒ unordered (hashtable, ...)



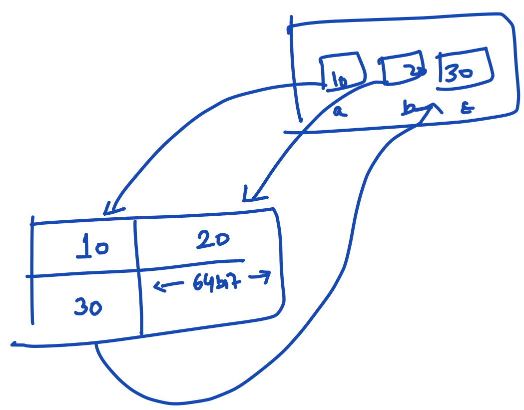
- Arraylist → array that can grow in size.

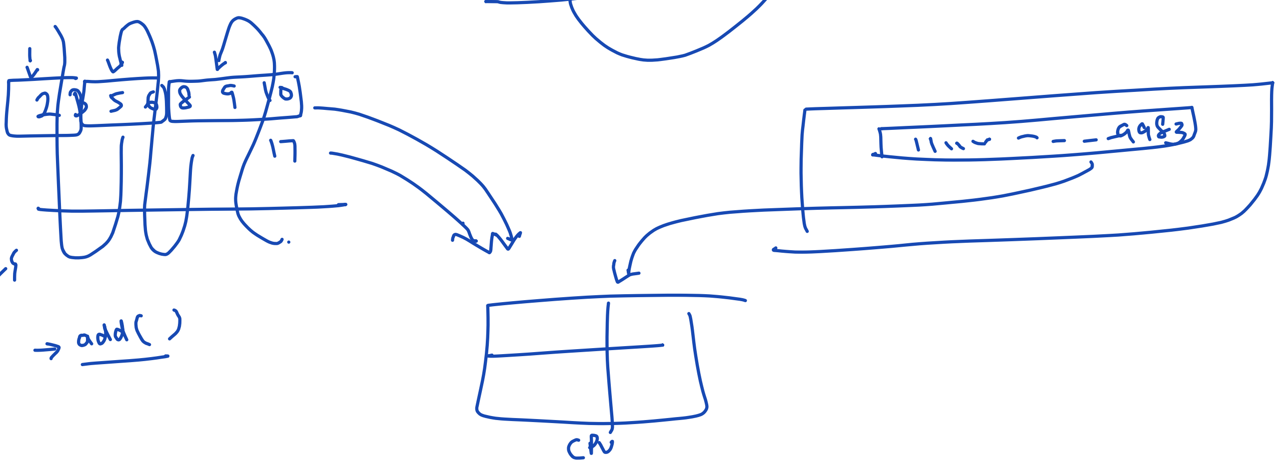
Hardware level

a = 10

b = 20

c = (a+b);





Big Integer {

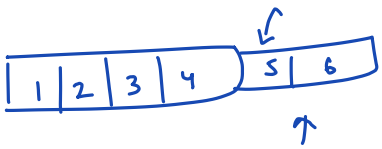
→ add( )

}

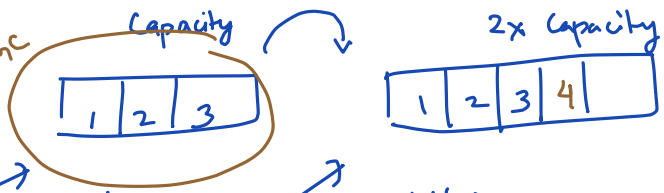
Class

HW: Go & Read about Wrapper Classes.

ARRAYLIST



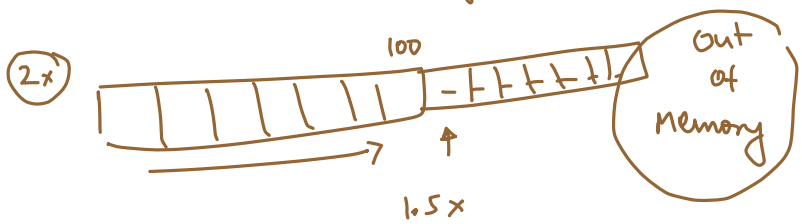
Growth



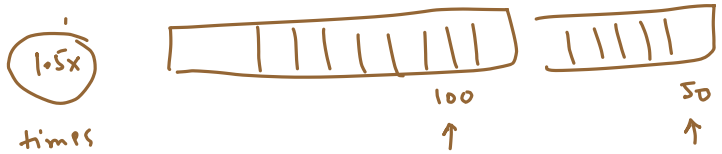
Depends

vector C++

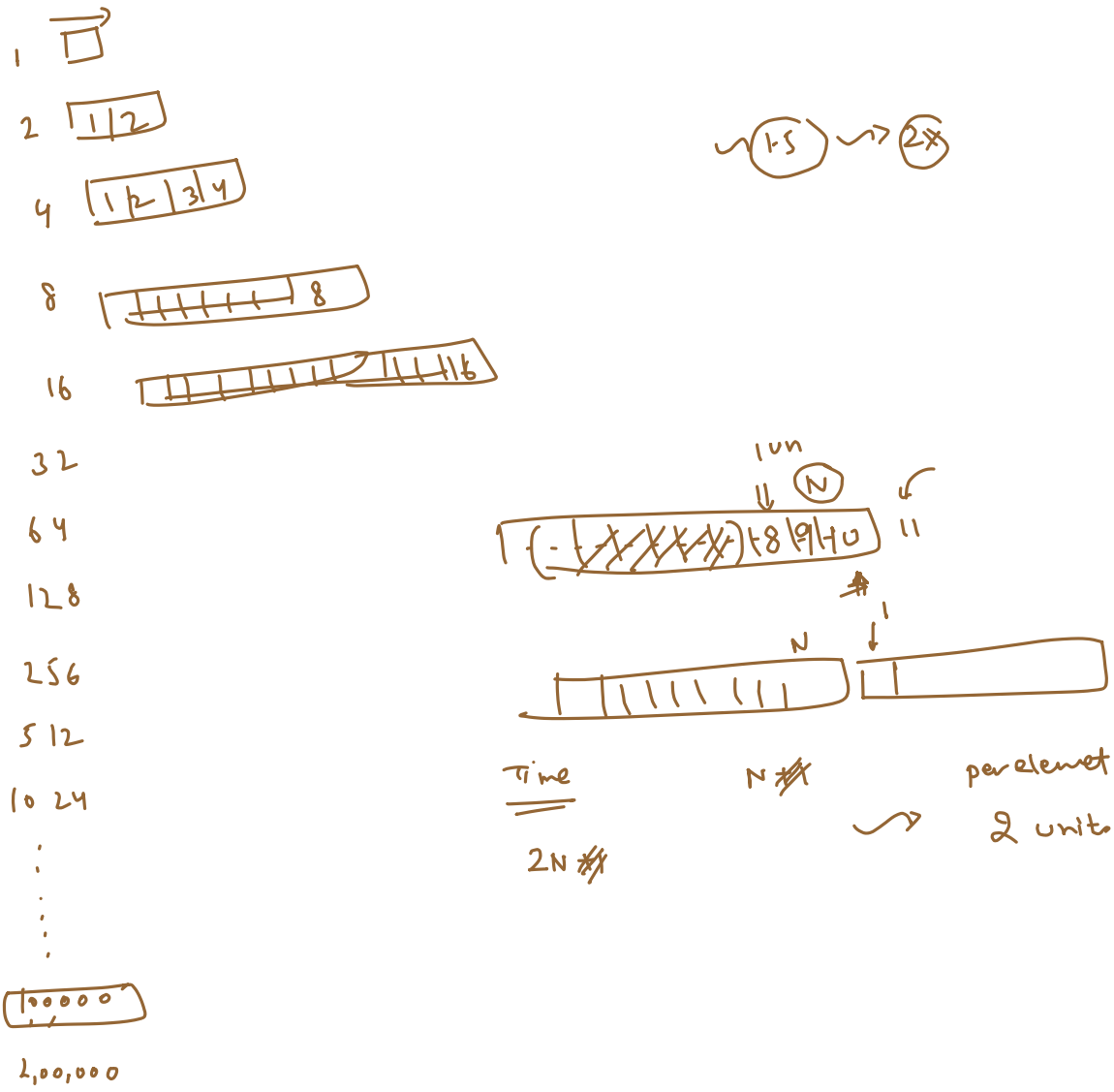
- ensure capacity()

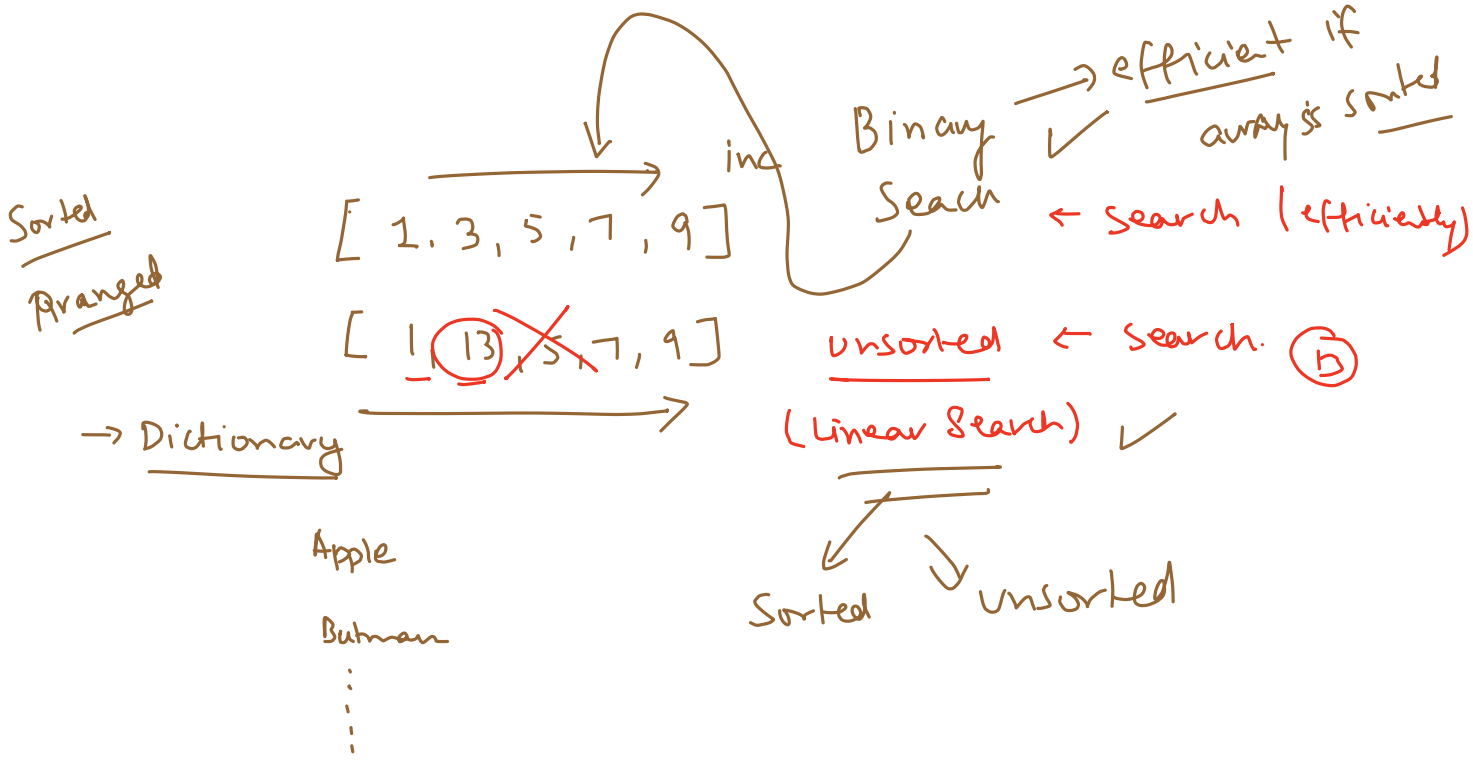


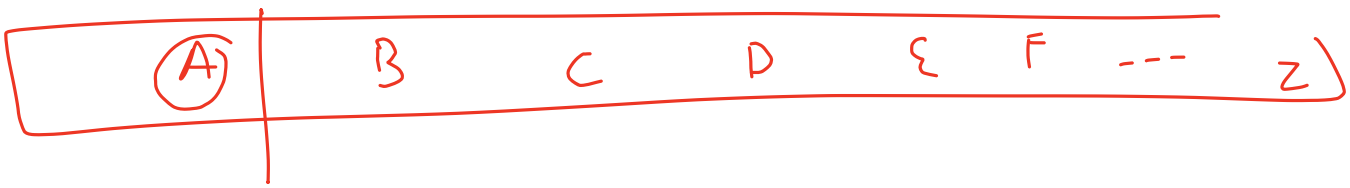
Java

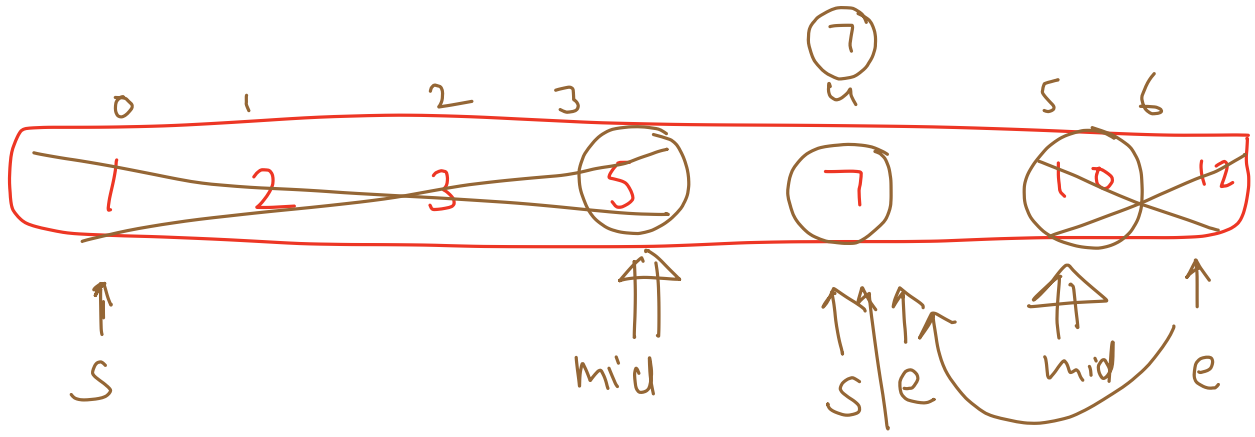


times


1
2
4
8
16
32
64
128
256
512
1024
2,00,000
1.5
2x
run
N
N
1
Time
N
2N
per element
2 units







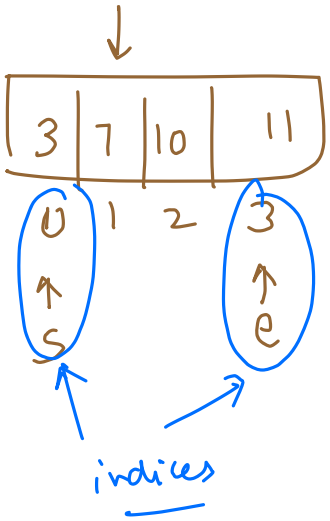
s → mid + 1 when a(mid) < key

e → mid - 1 when a(mid) > key

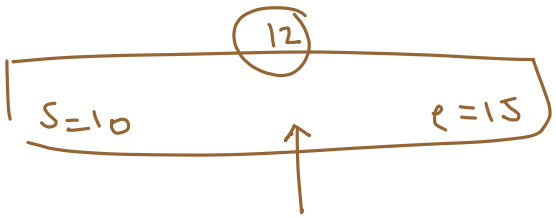
key search 7

5 < 7

10 > 7



$$mid = \frac{(s+e)}{2} = 1$$



$$mid = \frac{(s+e)}{2}$$

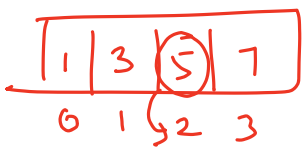
s

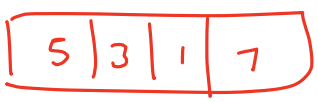
$$\frac{10+15}{2}$$

$$= \frac{25}{2}$$

Two Things ~~SORT~~ BS

① Change the loc of elements

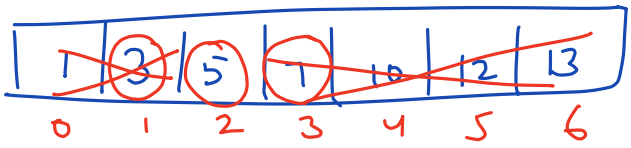




→ 0

→ ② ✗

② Time



key

6

mid e s

while(s<=e)
{ if a[mid] == key;
return mid;
elsif a[mid] > key

e = mid-1

s > e

Conclude?

STOP

$mid = \frac{s+e}{2}$

$= \frac{2+2}{2}$

else

else if a[mid] < key

s = mid+1

5 < b

3

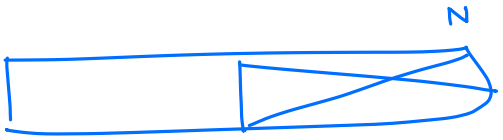
return false;

== if

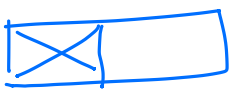
> else if <

< or > else ==

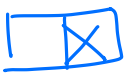
Modify ⇒ first occ



$\rightarrow O(N)$



$\rightarrow \frac{N}{2^1}$



$\rightarrow \frac{N}{2^2}$

$\Rightarrow$ 

$\rightarrow \frac{N}{2^3}$

$\frac{N}{2^k} = 1$

k^{th} step 

$\rightarrow \frac{N}{2^k}$

$\Rightarrow 2^k = N$

$\Rightarrow \log_2 2^k = \log_2 N$

$\log_A A^k = k \log_A A$

$\Rightarrow k$

$\Rightarrow \boxed{k = \log_2 N}$

fast	N	$\log_2 N$
~ 1000	1024 steps	10
$\sim 10^6$	10^6 steps	$\log_2 (1000)^2 = 2 \log 1000 = 20$
$\sim 10^9$		$= 30$
$\sim \boxed{10^{18}}$		$= 60$ steps

Time $10^8 \longrightarrow$ 1S Rule.

10^{10} seconds. (many years)