JVM

Stack   Heap

(Small)   (Larger)

                                          more
Funchons   ~~Create~~ Allocate memory during
                                    the runtime   (Dynamic)

Primitive   Objects
  int
  float
  Chav   PaintBrush
  boolean   Dog   Live on
  long   Scanner   the
  doubl e   String   heap
                               Arrays

fn → main() {

    Object → Scanner [SC] = new Scanner();   ← object Reference

    Primitive → int x = 10;   Print Brush. color

    object → String [name] = sc.next();   sc. data
        3   sc . action()

P R A T E E K

← → ← → ← → ← → ← →
2 bytes

14 bytes

+ Narang

Location →   Can be allocated as
per demand

1048 Heap   "P̶r̶a̶t̶e̶e̶k̶"

(Scanner)   Storage size i̶ ̶ ̶ flexible
                      Prateek Narang"
2158   ←→
→ ("Prateek" "Narang")   More letters
                              &
   ← Dynamic →   More
                            Memory

main

[10]
 x
[1048]
 SC
fixed→ [2158]
    name

$10^5 - 10^6$ fn calls

Stack ↑ faster acess
(limited storage)

Memory on the "fly" ↑ More storage
(Big Almirah)

Utils ← Package

↳ Alarm
↳ Clock
↳ PenStand
↳

Objects

class (Alarm)

↳ Time (Start)
↳ Duration : 5Mins
↳ Freq : ✓

alarm

Alarm
Start
=

Heap

Behaviour (Method/Fn)
↳ createAlarm() ←
↳ deleteAlarm()
↳ snooze()
↳ update()

run() {
=
}

Call a fun
↳ created
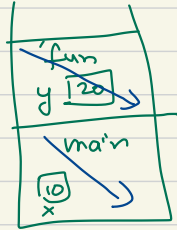
setAlarm()
=

main

fn ——
fn ==
fn ——
fn update

main() {

Alarm   alarm = new Alarm();

alarm. SetAlarm()

}

Life & Death on Stack

```
→ ⌈ fun() {
  ↓    → int y = 20;
  └    ⌡
  ⌐ main() {
       → int x = 10;
       → fun();
```

Top →
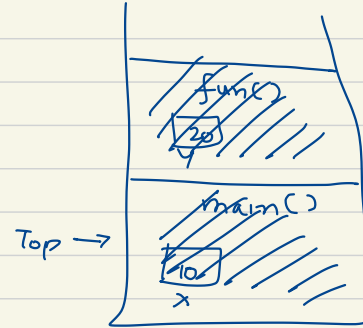
LIFO behaviour

Life & Death on Heap

Two things   main() {

    PaintBrush   B1 =   new P.Brush();   → Red, 5
    P. Brush   B2 =   new P. Brush();   → Blue, 10
    B1 = B2;

Allocation

3 ← exit

main

B1   B2

10↑   20↑

10↑   Red, 5

20↑   Blue, 10

Heap

↳ when no one
is refering
to
the obj.

free useless

Red, 5

201

Blue, 10

main

201
B1

201
B2

Garbage
Collector

↑
automatic
Java

eligible for GC
heap.

main

201
B1

201
B2

automatically
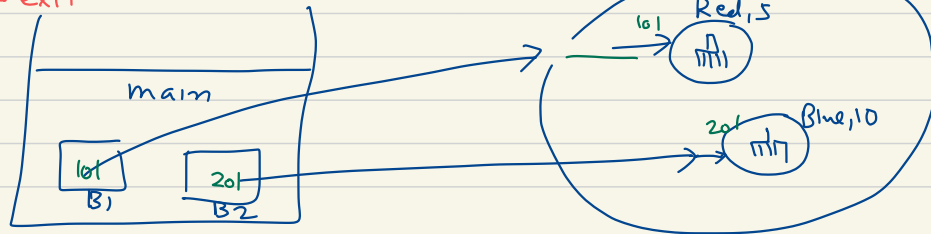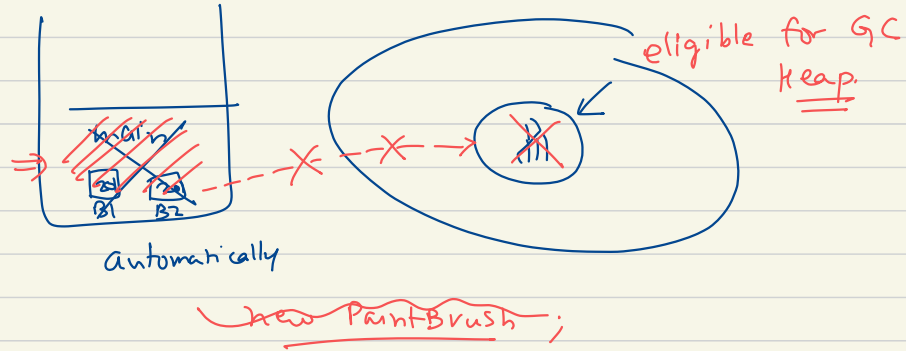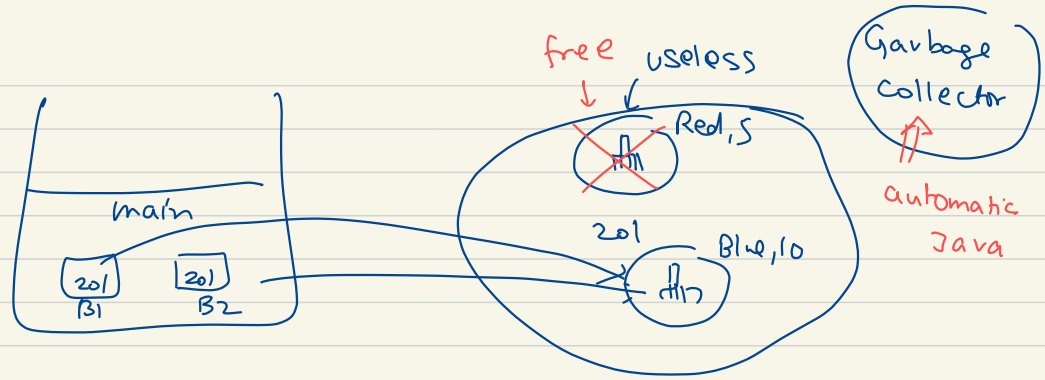
new PaintBrush ;

Paint Brush   get PaintBrush() {
                                     →local
        Paint Brush [b] = new Paint Brush(),
        return   b;   ↑
                                      Heap
    }
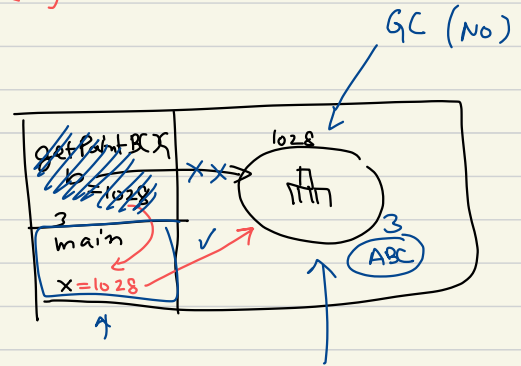   3

    main() {

        Paint Brush x = get PaintBrush();
                x = null;   x. color = "Red";

        String name = sc. next(),
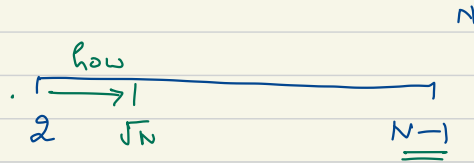   ↑
    }
              3

GC (NO)

Persist
even tmp
fn which
created
mem
is over

3 letters

"ABC"
"ABC -----.Z"
    26 letters

Mathematics

- Prime Numbers (optimise)

N

how

$2 \quad \sqrt{N} \longrightarrow 1 \qquad N-1$

$30 \longrightarrow 2,3, - - - - - - - \quad 29$

$30 \longrightarrow 2, - - - - \quad 5 \qquad$ Save time

$\sqrt{30}$

$11 \quad -2$
-3
-4
-5
-6
-7
-8
-9
-10

Not Prime

Small

$2, 3, 5, | 6, 10, 15$

↑

Big → $> \sqrt{N}$

30 — $\cancel{1} / \cancel{4} / \cancel{30}$

$2 \times 15 = 30$

$3 \times 10 = 30$

$5 \times 6 = 30$

$2, 3, 5, | 6, 10, 15$

2 to $N - \sqrt{N}$

$\boxed{\sqrt{N}}$

36 — $1 \cancel{\times} \cancel{36} /$

$2 \cancel{\times} 18$

3×12

4×9

6×6

$\leq \sqrt{N}$
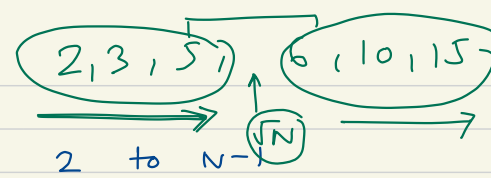
⇒ find @ divisor

Small divisor

$4 \downarrow \quad \overset{\sqrt{N}}{⑥} \times \overset{\sqrt{N}}{⑥} 9 = 36 \quad Ⓜ$

$2, 3, 4, 6, | 6, 9, 12, 18$

Small $\leq \sqrt{N}$

Big $> \sqrt{N}$
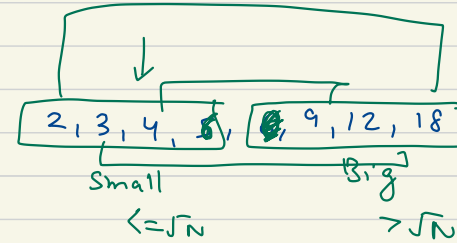
$ⓐ \times b↑ = 36 \; N$

$\underset{\text{must be less than } \sqrt{N}}{↓} \quad > \sqrt{N}$

$i^2 <= N$

$\rightarrow$ $i <= \sqrt{N}$

boolean is Prime (int A) {

$\rightarrow$ Div less than equal to $\sqrt{N}$

$i <= \sqrt{N}$

int i;

$\rightarrow$ faster

for (i=2; $\boxed{i * i <= N;}$ i++) {

earlier

if (N%i==0)

$\boxed{i <= N-1}$

return false

3

3

return True;

10,000

$\sqrt{10,000}$ $\rightarrow$ 100 steps

$\curvearrowright$ 10,000 steps

2 —— N-1

46   i = 2

46%2 == 0
        ↳ # Not Prime

47   i = 2   ∌ i² <= 47
47   ↳ i = 3   4 <= 47
47   ↳ i = 4   9 <= 47
47   ↳ i = 5   16 <= 47
47   ↳ i = 6   25 <= 47
            ↳ i = 7   36 <= 47
Prime   49 ✗= 47
            stop

o─────────────////////////////o   47
2   46

o───────────o
2   7

N = 100

N/2 = 50   X

√N = ⑩ ✓

10⁶ Ⓜ

↳ 1000 steps

(31)

$$i^2 <= N$$
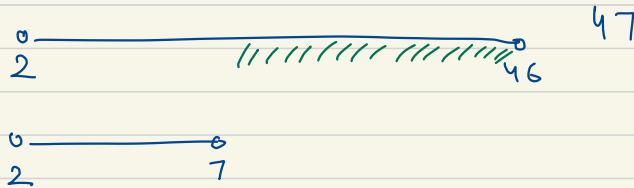
$i=2$	$4 <= 31$	$31 \% 2$ NO
$\downarrow$		
$i=3$	$9 <= 31$	$31 \% 3$ NG
$\downarrow$		
4	$(6 <= 31)$	$31 \% 4$ NO
$\downarrow$		
5	$25 <= 31$	$31 \% 5$ NO
$\downarrow$		
6	$36 <= 31$	Stop $(PRIME)$

10 digits → 0, 1, 2, 3, 4, 5, 6, 7, 8, 9

Decimal

N = $\dfrac{1\ 2\ 3}{10^2\ 10^1\ 10^0}$ Base 10

=

1×10^2
$+ 2 \times 10^1$
$+ 3 \times 10^0$

= $100 + 20\!\!\!/ + 3$
= $\boxed{123}$

Base ②

Binary   2 unique digit   0 and 1

8   4   2 1

$\boxed{1\ 0\ \ 1\ 0}$

$2^3\ \ 2^2\ \ \ 2^1\ 2^0$

= 1×2^3

$+ 0 \times 2^2$ = $8 + 2$
$+ 1 \times 2^1$ = $\boxed{10}$
$+ 0 \times 20$

$2^3\ \ 2^2\ \ 2^1\ \ 2^0$
$\times\ \ \times\ \ \ \times\ \ \ \times$
$\boxed{1\ 0\ 1\ 1}$

= $8 + 0 + 2 + 1$
= $\boxed{11}$

$2^4\ \ 2^3\ 2^2\ \ 2^1\ \ 2^0$
$\boxed{1\ 1\ 1\ 0\ 1}$
= $16\ \ 8\ \ 4\ \ 2\ \ 1$

= $16 + 8 + 4 + 1$
= $\boxed{29}$

2^3 2^2 2^1 power $2^0 = 1$

32 16 $8 \curvearrowleft 4$ $2 \curvearrowleft 1$ 1

int N = ✗ ✗ ✗ ✗ ✗

power = 1 $2^0 = 1$
ans = 0

Loop while (N > 0) {

→ [last_digit = N % 10 ;

      ans = ans + last_digit * power

→ [N = N / 10

$\left(\frac{1}{10}\right) \Rightarrow 0$

      power = 2 * power ;

3

= 0 + 1 * 1   = 1
= 1 + 0 * 2   = 1
= 1 + 1 * 4   = 5
= 5 + 1 * 8   = 13
= 13 + 1 × 16 = 29

$$16 \quad 8 \quad 4 \quad 2 \quad 1$$

$$N = |1\ 0\ 0\ 0\ 1|$$

$$N = \left(\frac{1}{10}\right) = 0$$

ans = 0

$$0 + \quad 1 \times 1 = 1$$

$$1 + 0 \times 2 = 1$$

$$1 + 0 \times 4 = 1$$

$$1 + 0 \times 8 = 1$$

$$1 + \quad 1 \times 16 = \boxed{17}$$

stop

Binary to Decimal ✓

Dec to Binary ✓

(23)

Long Div Method (Pen & Paper)

N

2) 23
2) 11 , 1
2) 5 , 1
2) 2 , 1
2) 0 , 0
0 , 1

Top
Bottom

$2 \times (11) + (1) = 23$

16 8 4 2 1
1 0 1 1 1
= 16+4+2+1
= (23)

2) 39
2) 19 , 1
2) 9 , 1
2) 4 , 1
2) 2 , 0
2) 1 , 0
0 , 1

(32) 16 8 (4)(2)(1)
1 0 0 1 1 1

$32 + 4 + 2 + 1$
= 39

while (N>0) {
    print N%2   1 ✗ 0
    N = N/2;
}

3

More

$$2 \underline{|\, 1\,4}$$
$$2 \underline{|\, 7, 0}$$
$$2 \underline{|\, 3, 1}$$ ①
$$2 \underline{|\, ① , ①}$$
$$0 , ①$$

$\times 10^0$ ← power = 1 = 0
$\times 10^1$ +
$\times 10^2$ $-\, 10$
$\times 10^3$ $+\, 100$
$+\, 1000$

ans = 0, P = 1

while (N > 0) {

  rem = N % 2;
  ans = ans + rem * p;

  [⇒ P = 10 * P;
    N = N / 2;

3

print (ans),

= 1 1 1 0
= 1000
  + 100
  + 10
  + 0
  ‾‾‾‾
  1110

8 4 2 1
1 1 1 0

8 + 4 + 2 = ⑭

      a   ans   P = 1
     N = 14   0
     14 0   0 + 0×1 = 0
     7   0 + 1×10 = 10
     3   10 + 1×100 = 110
     1   (10 + 1×1000 = 1110

     0 Stop

GCD

Pen & Paper

$$40, \quad 15$$

A → (15) $\overset{2}{\overline{\smash{\big)}40}}$ B

30

$\overset{1}{10 \smash{\big)} 15}$

$\overset{2}{5 \smash{\big)} 10}$

10

$0 \smash{\big)} (5)$
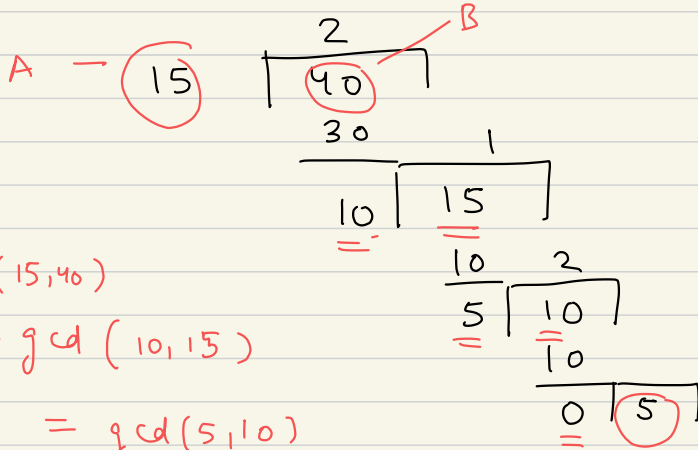
$\gcd(15,40)$

$= \gcd(10,15)$

$= \gcd(5,10)$

$= \gcd(0,5)$ ↑ → (gcd)

Slow

$$2 \overline{8}$$

$$4 \overline{8}$$

8	,	12

$i = 1$ ✓   ✓

$i = 2$ ✓   ✓

$i = 3$ ✗   ✗

$i = 4$ ✓   ✗

5

$1 6$

$⊗ 7$

$8 $ ✗   ✗

gcd
1
2
(4)

gcd
=

6   18 , 60

$gcd = 6$

A → 18 | 60 ← B
        3
        60
        54
A' → 6   18 ← B'
              3
        18
        0   6
            ↑
           gcd

A → 6 | 18 ← B

|‒ ‒ ‒ ‒ ‒ 18
18 steps

3 steps

A , B

Loop (till A > 0) {

A' = B % A ;
B' = A

A = A'
B = B'

3