

Time complexity:-

ms c)

- ① ms (first half)
- ② ms (right half)
- ③ Merge

$$T(n) = T\left(\frac{n}{2}\right) + T\left(\frac{n}{2}\right) + O(n)$$

$$T(n) = 2T\left(\frac{n}{2}\right) + O(n)$$

substitution method

$$T\left(\frac{n}{2}\right) = 2T\left(\frac{n}{4}\right) + \frac{n}{2}$$
$$T(n) = 2\left[2T\left(\frac{n}{4}\right) + \frac{n}{2}\right] + n$$
$$= 2^2 T\left(\frac{n}{4}\right) + 2n$$

$$T\left(\frac{n}{2^2}\right) = 2T\left(\frac{n}{2^3}\right) + \frac{n}{2^2}$$
$$T(n) = 2^3 T\left(\frac{n}{2^3}\right) + 3n$$
$$\vdots$$
$$T(n) = 2^k T\left(\frac{n}{2^k}\right) + kn$$

$$\frac{n}{2^k} = 1$$
$$n = 2^k$$
$$\log n = \log 2^k$$
$$\log n = k \log 2$$
$$k = \log n$$
$$T(n) = 2^{\log n} T(1) + n \log n$$
$$= n \cdot 1 + n \log n$$
$$= n \log n$$

Worst best Avg

SC $\Rightarrow O(n)$

No. of call stack

Median

1 2 3 3 4 6 7 10 12 15 10

$$\frac{4+6}{2} \Rightarrow 5$$

1 2 3 4 5

arr1 = 1 3 4 7 10 12 2

arr2 = 2 3 6 15

merge

1 2 3 3 4 6 7 10 12 15

even $\Rightarrow \frac{l+r}{2}$

odd $\Rightarrow \text{middle}$

$$TC \Rightarrow O(m+n)$$

$$SC \Rightarrow O(m+n)$$

1 2 3 3 4 6 7 10 12 15

5th 6th

$\frac{4+6}{2} = 5$

arr1 = 1 3 4 7 10 12

arr2 = 2 3 6 15

5-2 \Rightarrow 3
5-4 \Rightarrow 1
5-3 \Rightarrow 2

1 2 3 3 4 6 7 10 12 15

7 < 3

④ X 1 3 4 7 10 12
2 6 15

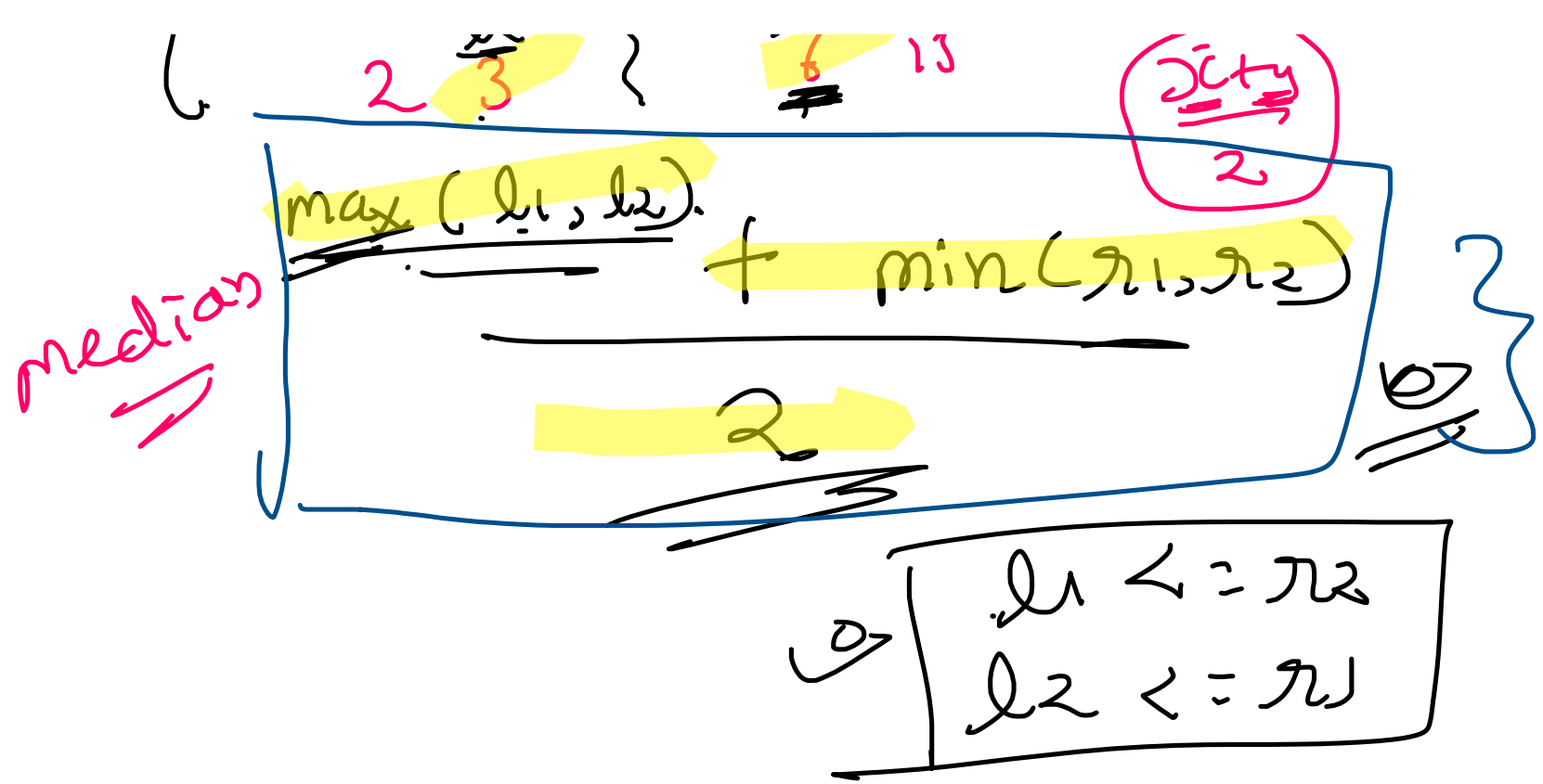
⑤ 1 3 4 7 10 12
2 3 6 15

② X 1 3 4 7 10 12
2 3 6 15

$$4 < 6$$

$$3 < 7$$

1 3 4 7 10 12



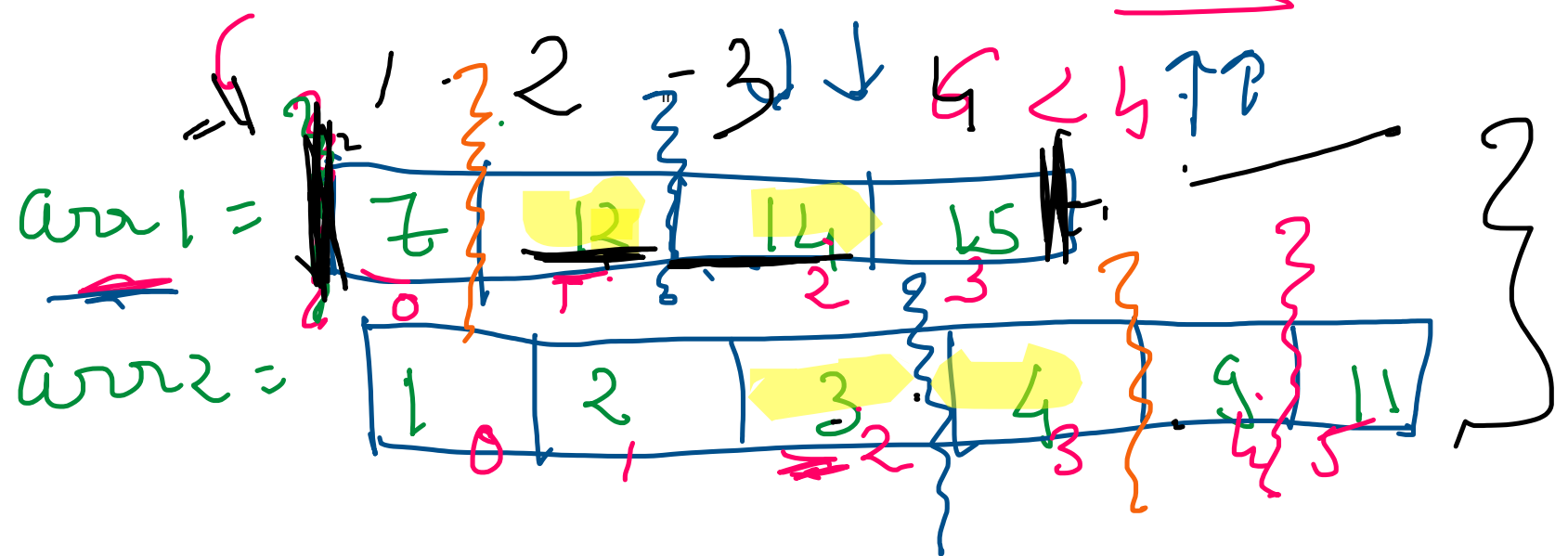
$arr_1: 1 \ 3 \ 4 \ 7 \ 10 \ 12$
 $arr_2: 2 \ 3 \ 6 \ 15$

$1 \ 3 \ 4 \ 7 \ 10 \ 12$
 $2 \ 3 \ 6 \ 15$

$1 \ 3 \ 4 \ 7 \ 10 \ 12$
 $2 \ 3 \ 6 \ 15$

$\{ 1 \ 3 \ 4 \ 7 \ 10 \ 12 \}$
 $\{ 2 \ 3 \ 6 \ 15 \}$

$(10)/2 \Rightarrow 5$
 $5-2 \Rightarrow 3$
 $O(m+n) \Rightarrow O(n)$



$low = 0$
 $high = 4$
 $cut1 = \frac{low + high}{2}$
 $= \frac{0 + 4}{2} = 2$

$cut2 = 5 - 2 = 3$

$high = mid - 1$
 $low = 0$
 $high = 2 - 1 = 1$

$cut1 = \frac{0 + 1}{2} = 0$

$cut2 = 5 - 0 = 5$

$min \leq 11$

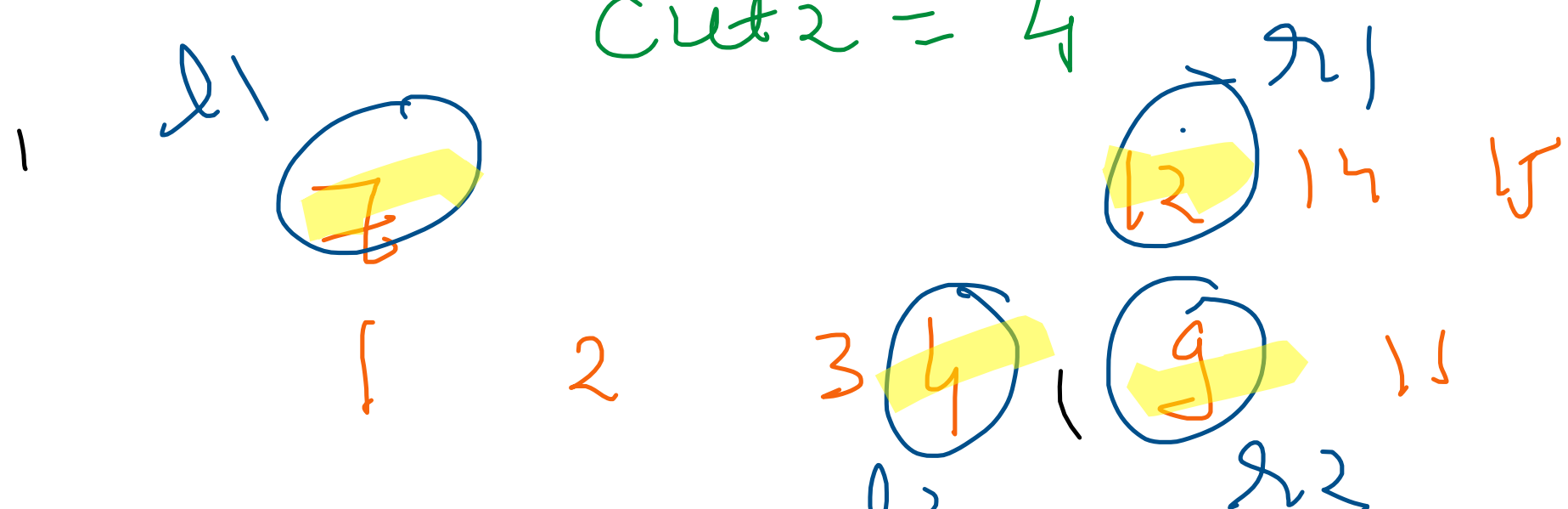
$9 \leq 7$

$low = mid + 1 = 0 + 1 = 1$

$high = 1$

$cut1 = \frac{1 + 1}{2} \Rightarrow 1$

$cut2 = 4$

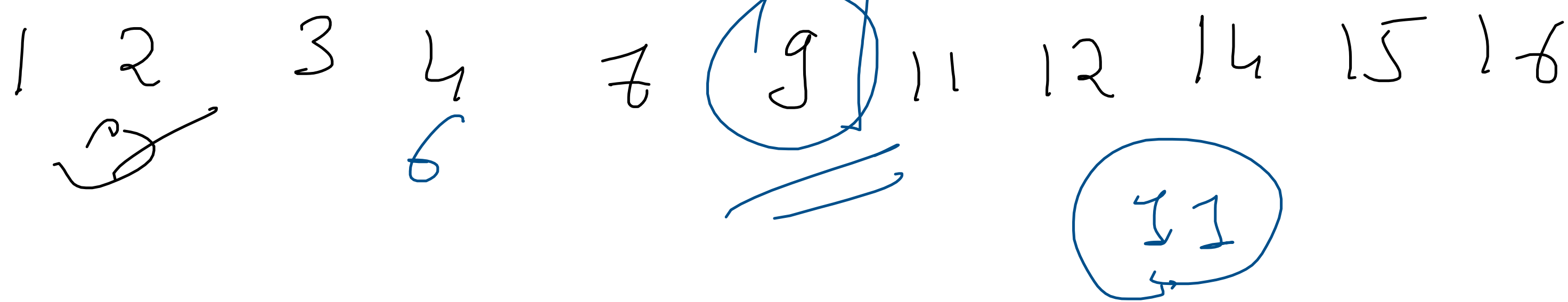


$$7 < 9 \Rightarrow$$

$$4 < 12 \Rightarrow$$

$$\frac{\max(l_1, l_2) + \min(r_1, r_2)}{2}$$

$$\frac{7+9}{2} \Rightarrow 8$$



$$\frac{n_1 + n_2}{2}$$

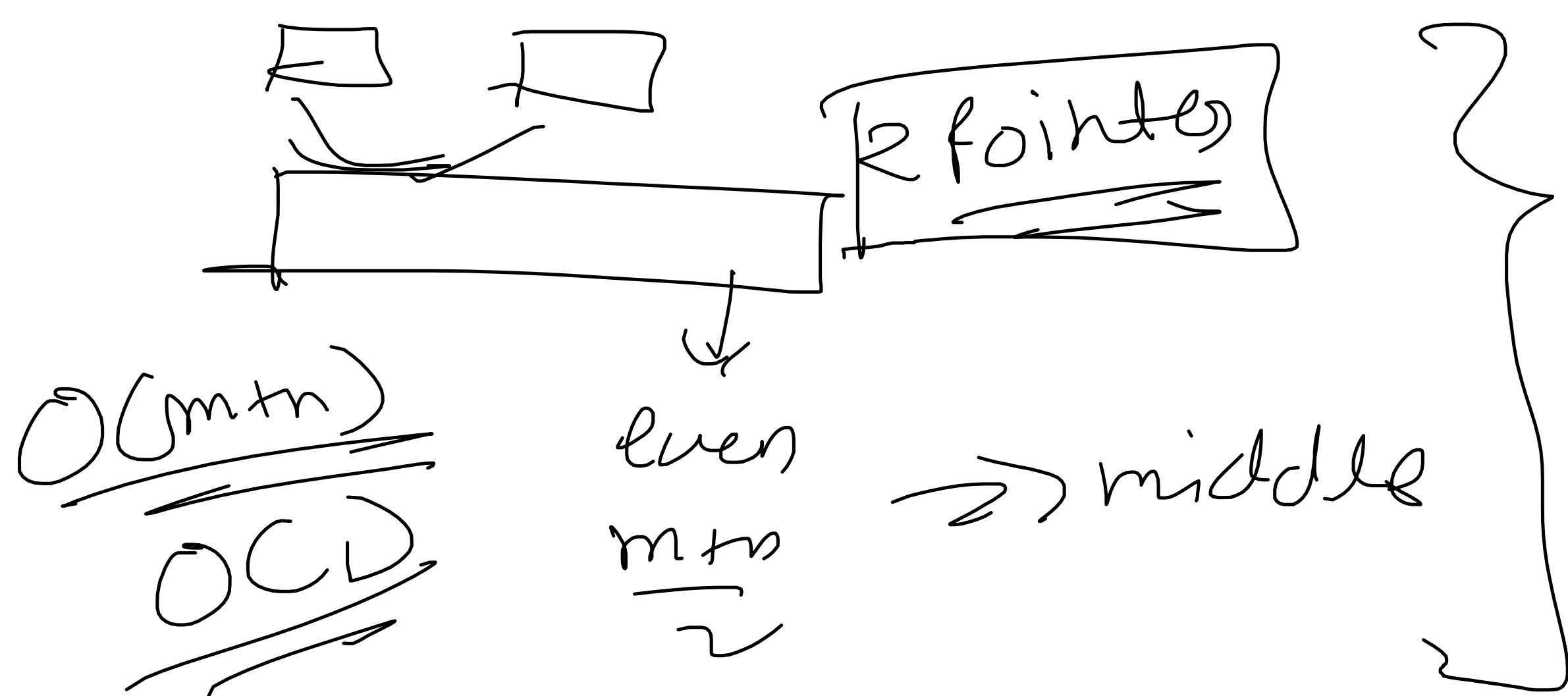
$$\frac{n_1 + n_2 + 1}{2} \Rightarrow$$

$$\frac{6 + 5 + 1}{2} \Rightarrow$$

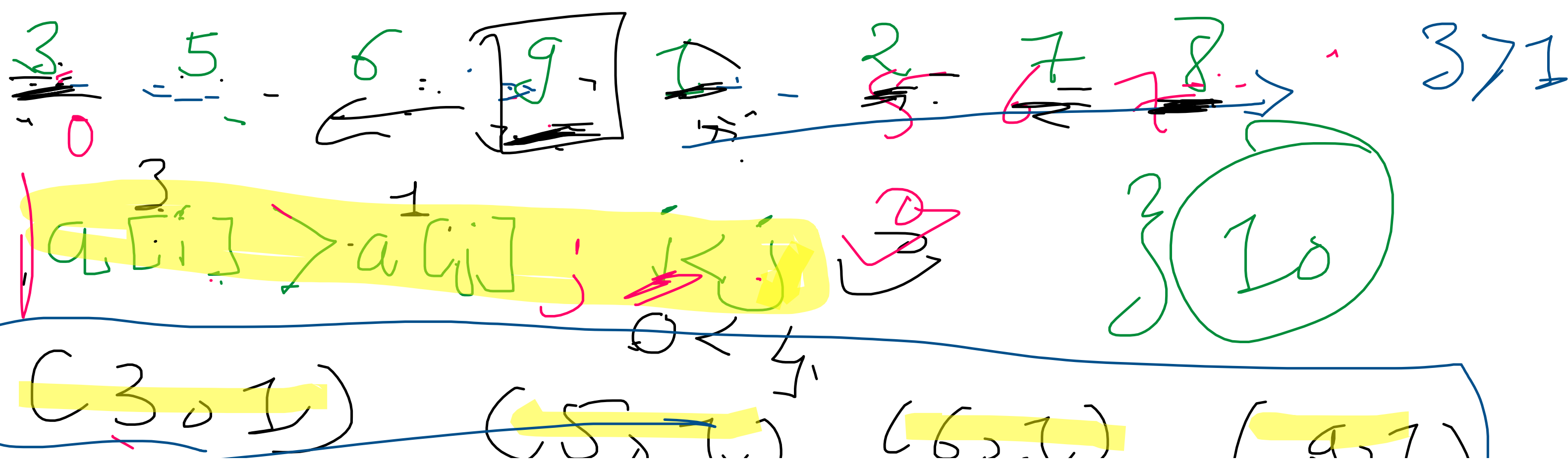
$$\Rightarrow 9$$

median :- $\max(l_1, l_2)$

$$\frac{n_1 + n_2 + 1}{2}$$



Count inversion



$(3, 2)$ $(5, 2)$ $(6, 2)$ $(9, 2)$
 $(9, 7)$ $(9, 8)$

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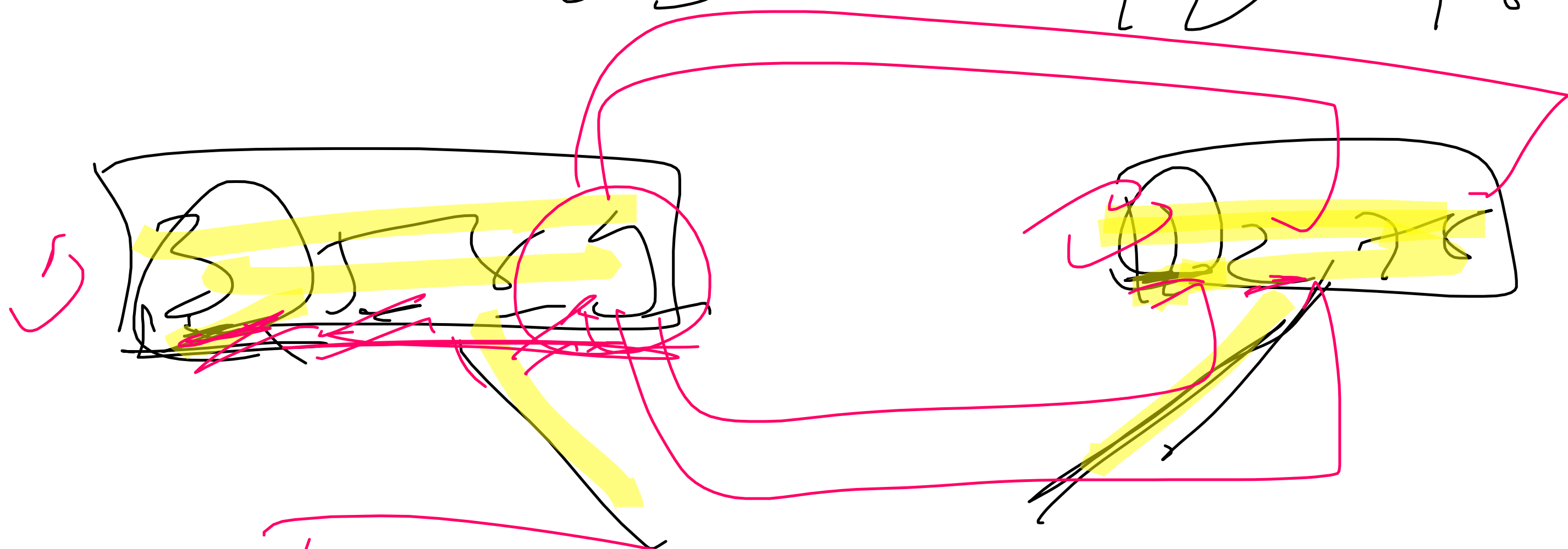
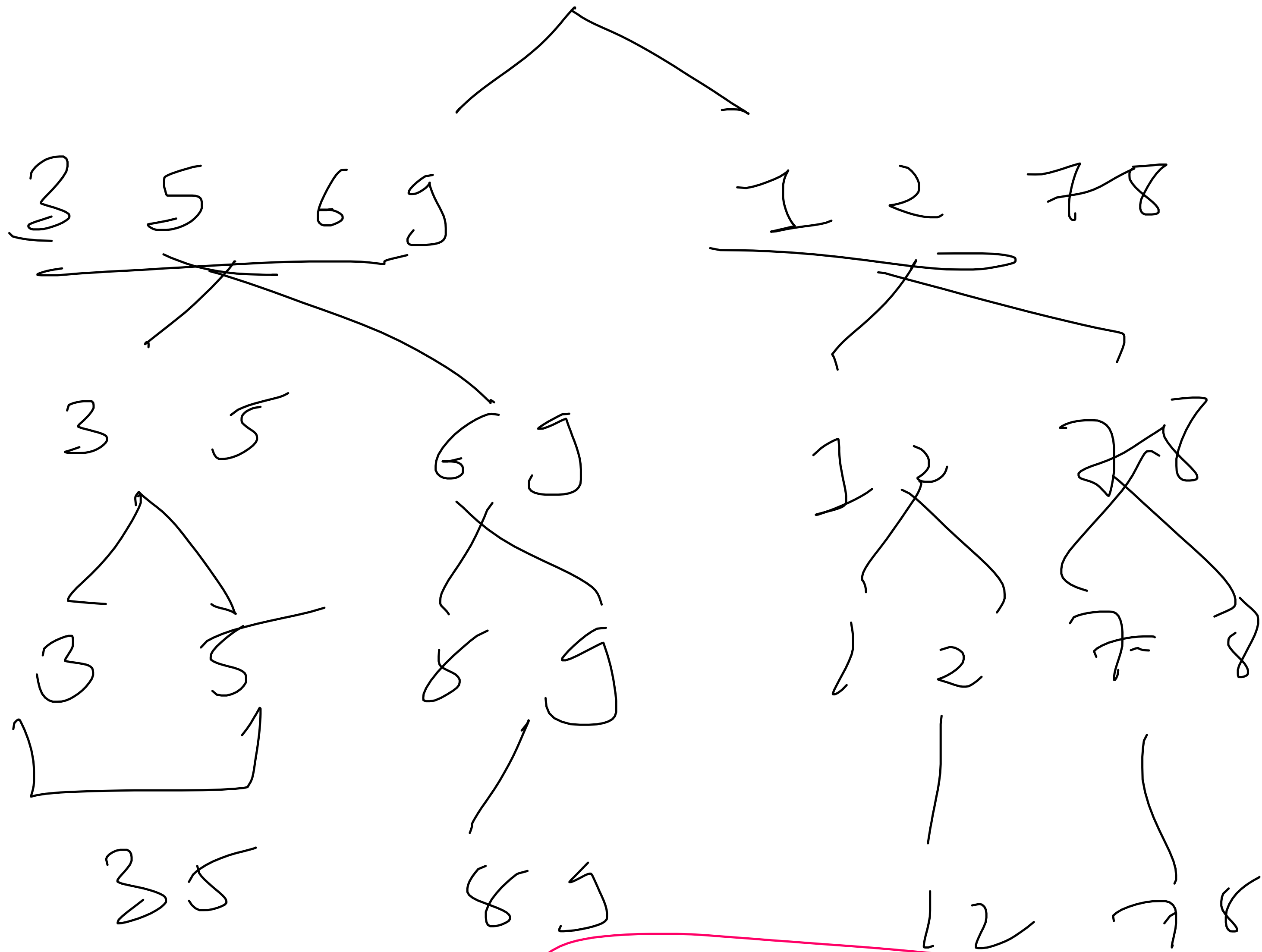
    k++; k = 1;
}
else{
    arr[k] = a2[p2]; arr =
    p2++;
    k++; k = 1;
    inv += (m1 - p1); //
}
}

```

$m1 = 4$
 $p1 = 0$

$m1 - p1$

~~3~~ ~~5~~ ~~6~~ 9 ~~1~~ ~~2~~ ~~7~~ ~~8~~



$4 - 0 \Rightarrow$

$4 + 4 + 2 \Rightarrow$

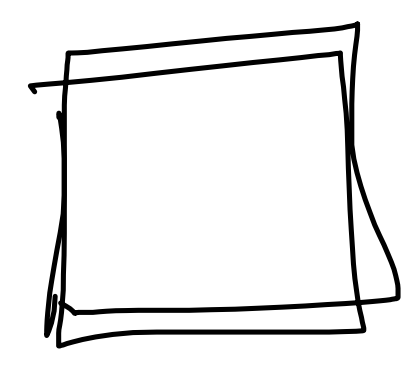
112, 124

~~Ver~~

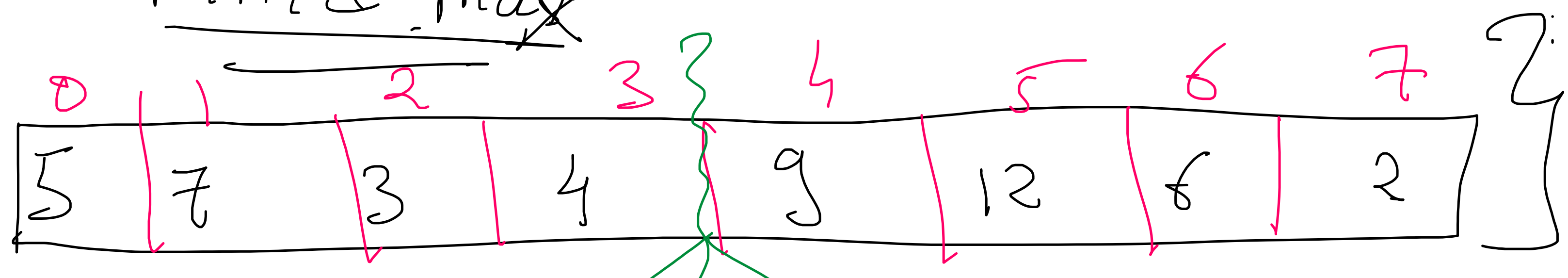
Double inversion

$\Rightarrow [a[i] > 2 * a[j]] ; i < j$

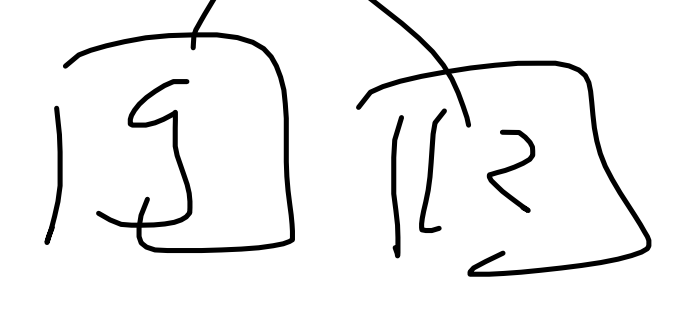
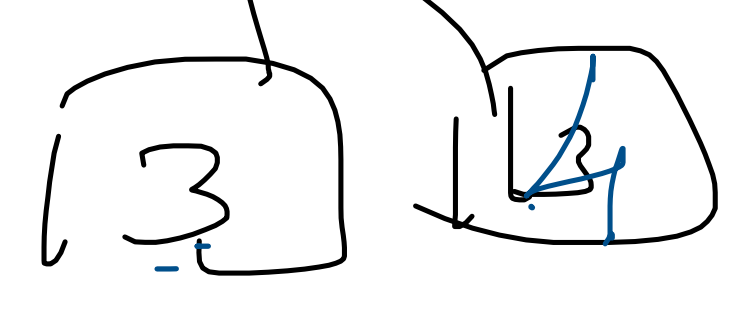
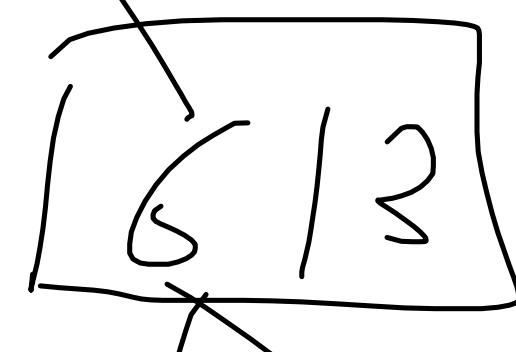
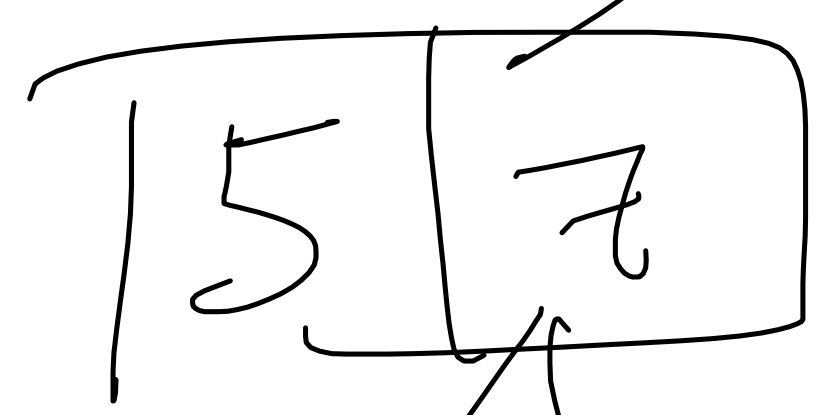
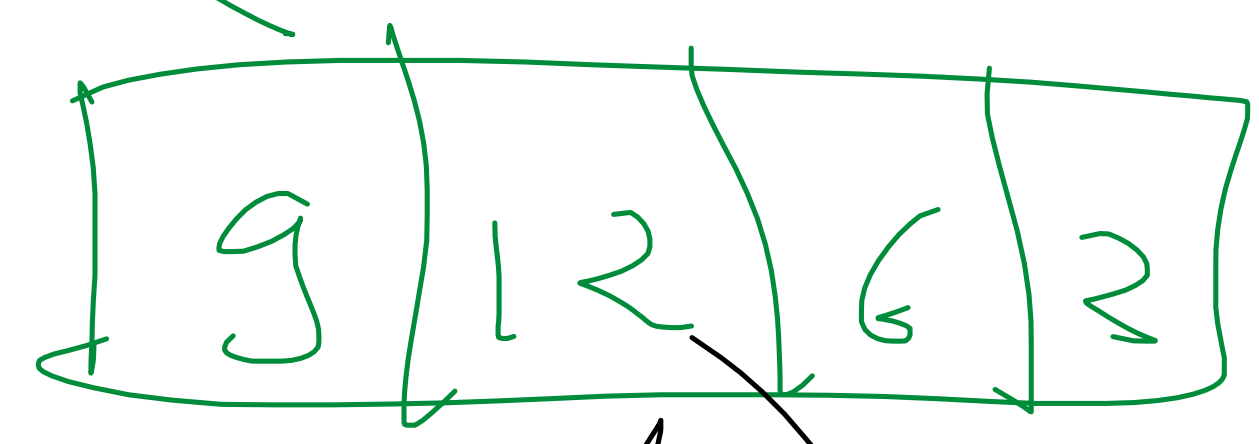
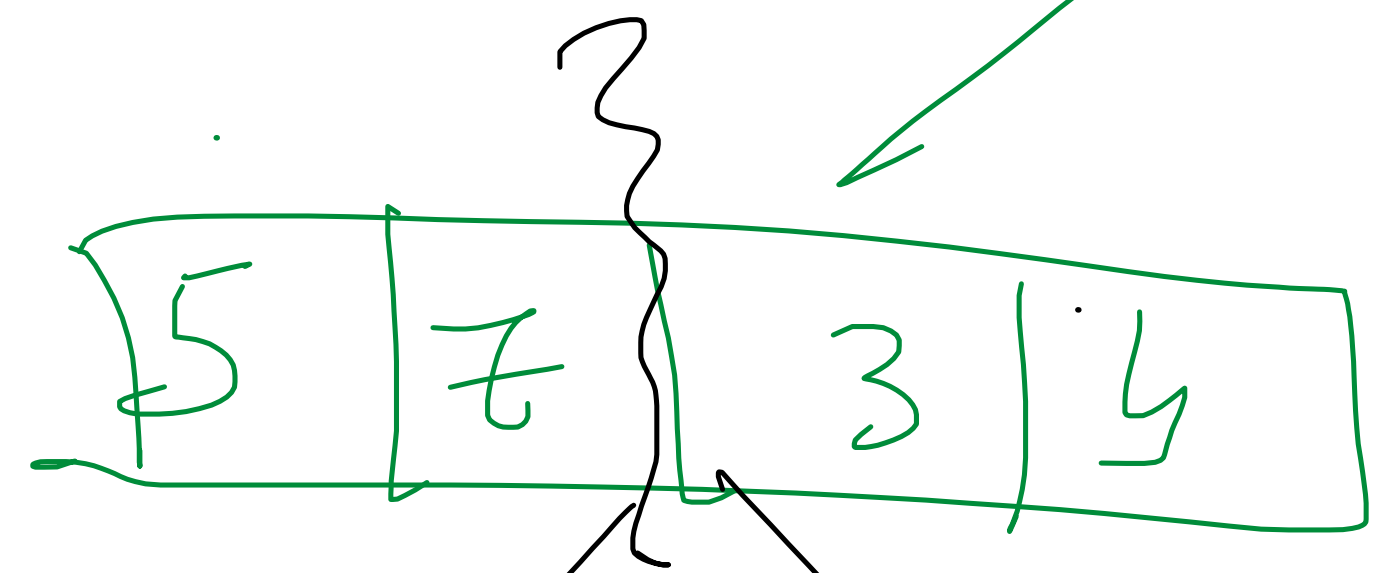
$a[i] > a[j] ; i < j$



min & max



$mid = \frac{0+7}{2} \Rightarrow 3$



max = 7
min = 5

min = 3
max = 4

min = 9
max = 12

max = 7
min = 3

max = 12
min = 2

DEC

max = 12
min = 2



