

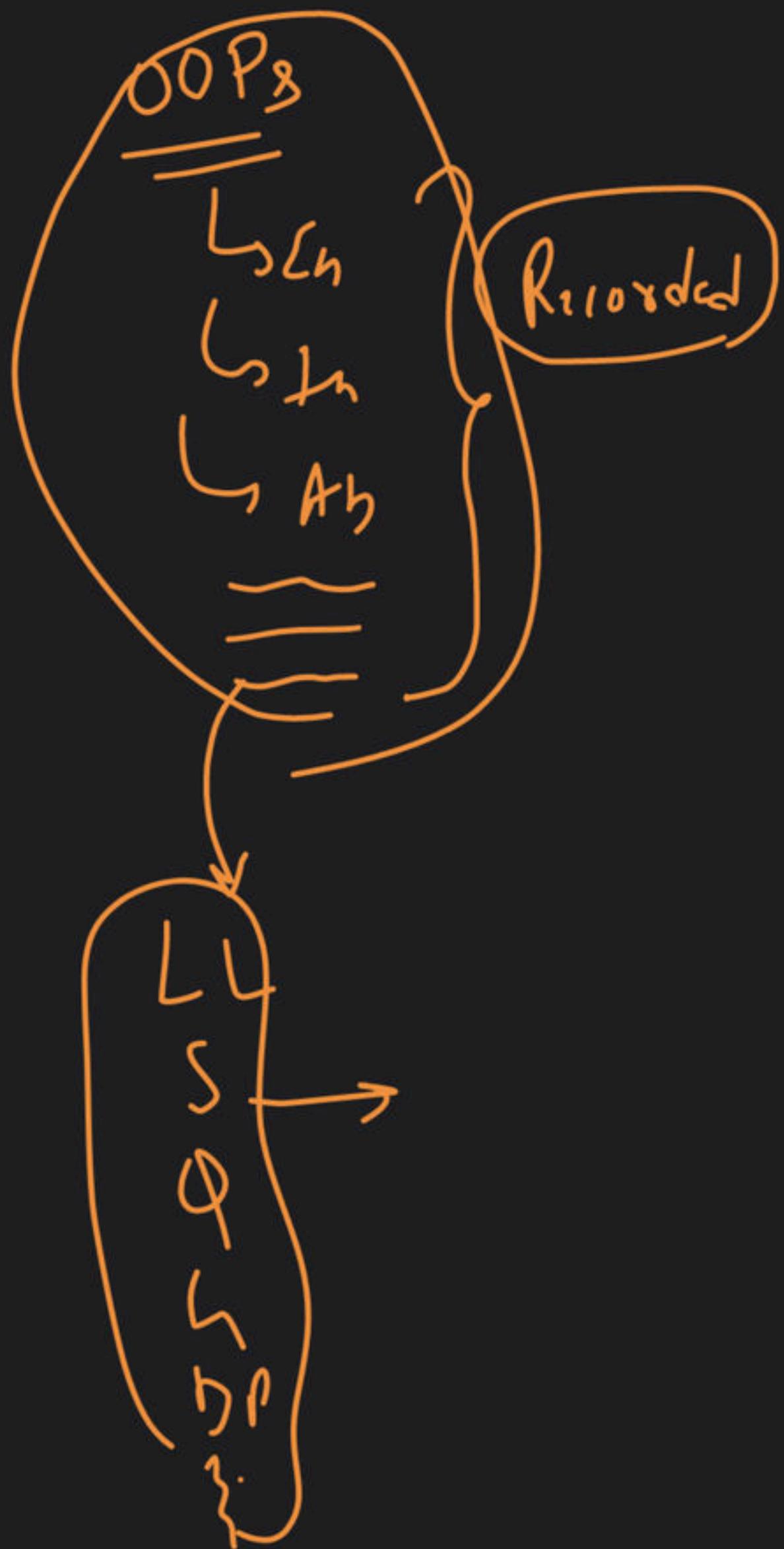
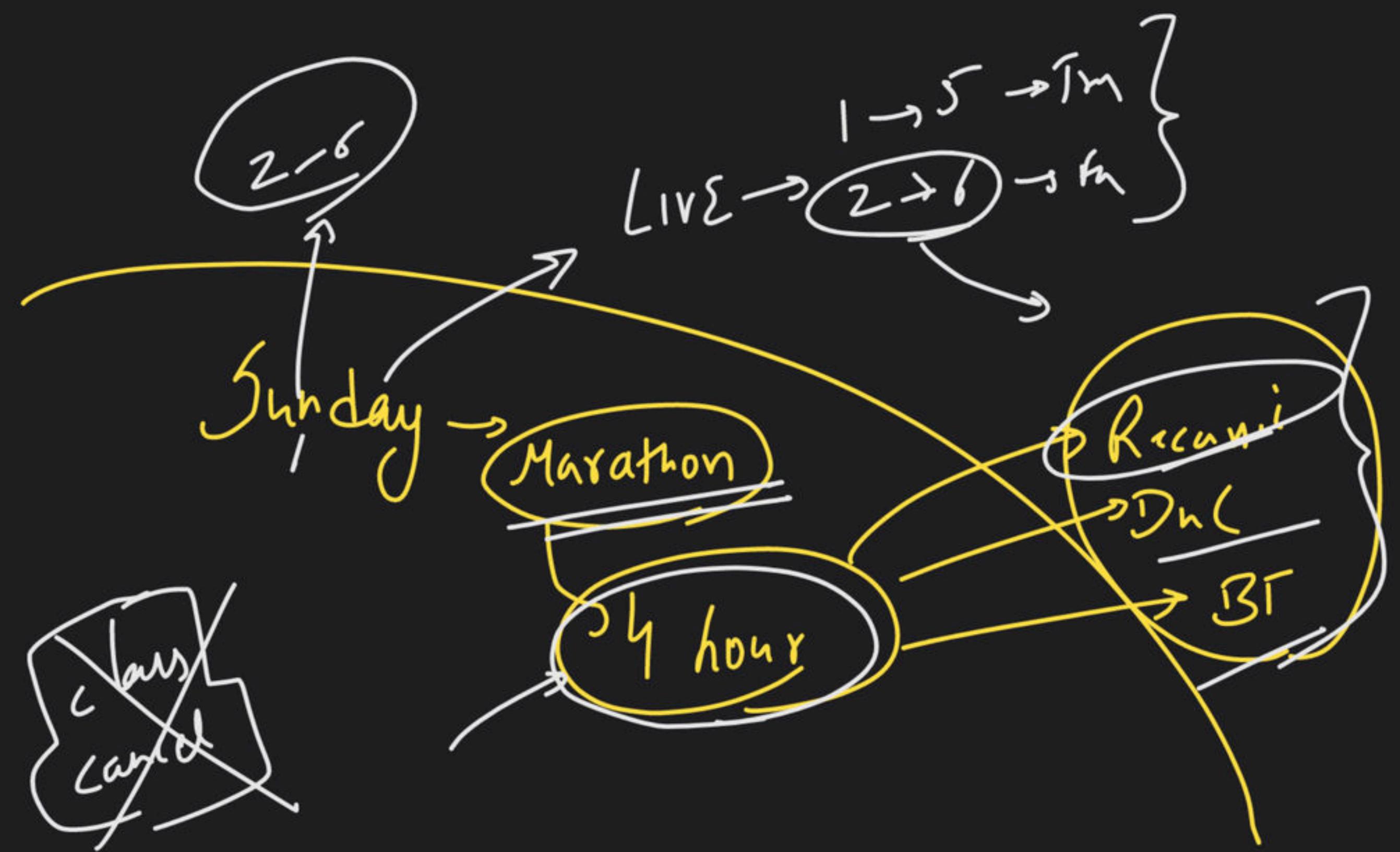
DnC Class - 1

Special class

Dynamic Memory Allocation

Merge Sort

~~Merge Sort~~



Merge Sort

Merge

6. C?

g2 L.

T-LS?

→ Merge Sort

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

thr

2 hr

Right Lat

i/p

I → find mid

break

II → Rec

III → may 2
sort it away



Left

Right

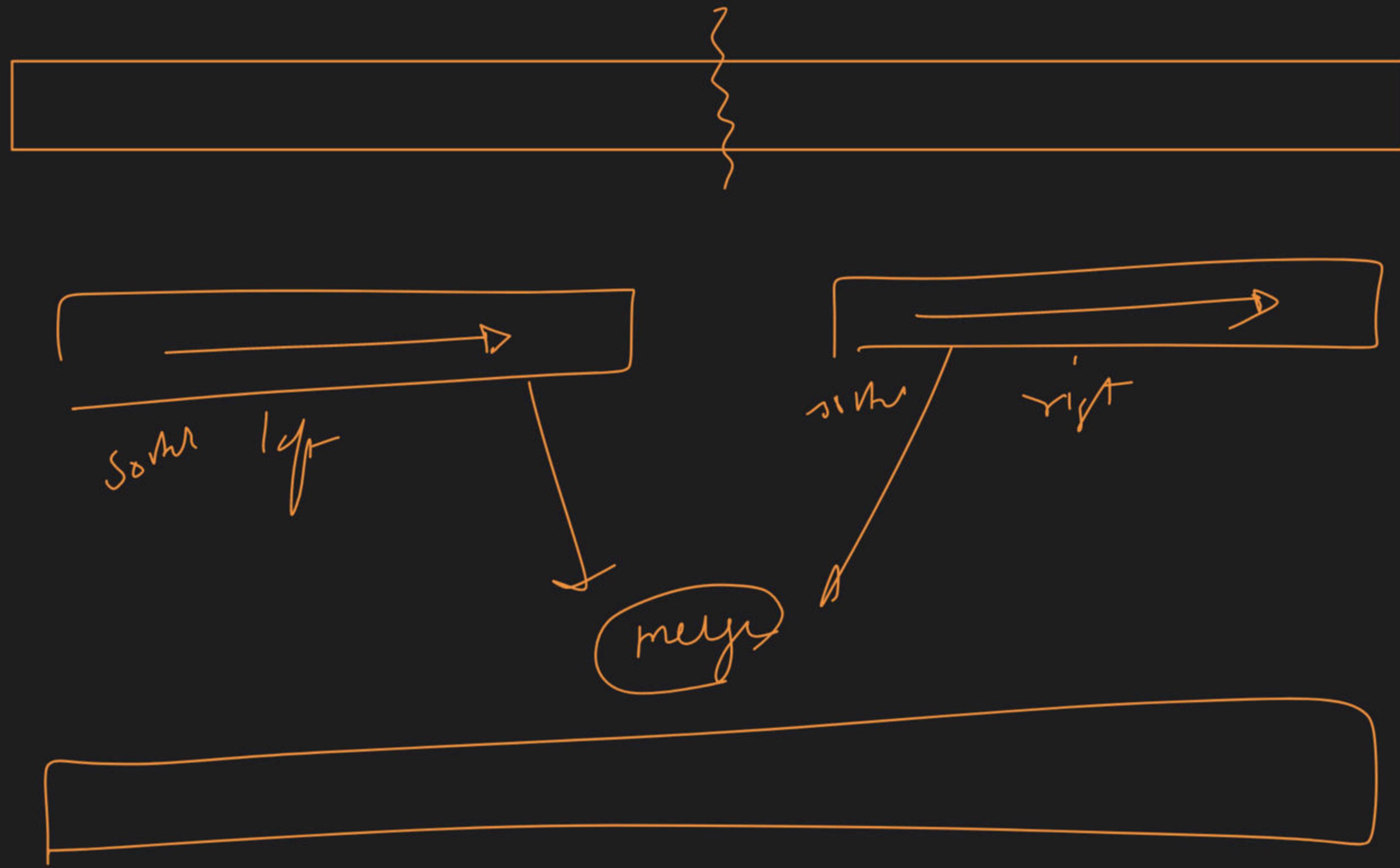


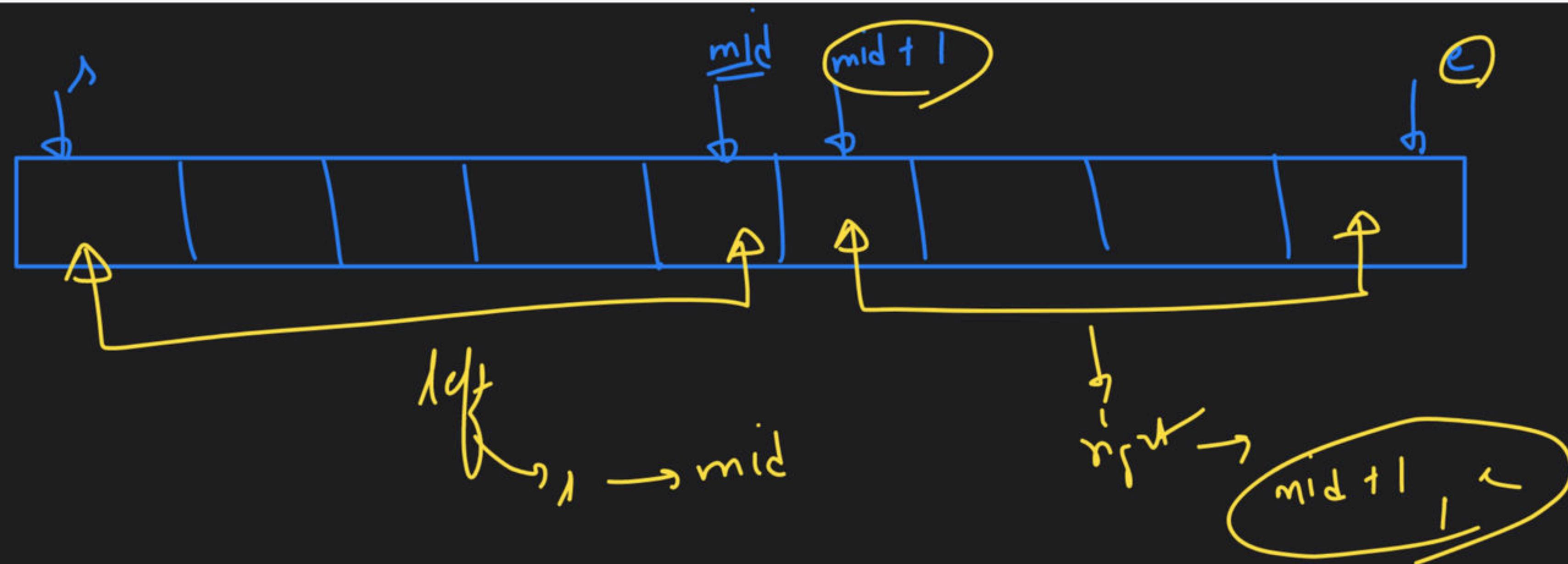
sorted Left part



sorted Right part

may





break into left & right half

recursion

merge 2 sorted arrays

93.1

mergeSort (arr, s, e)

```
// B.C  
if(s > = e)  
    return;
```

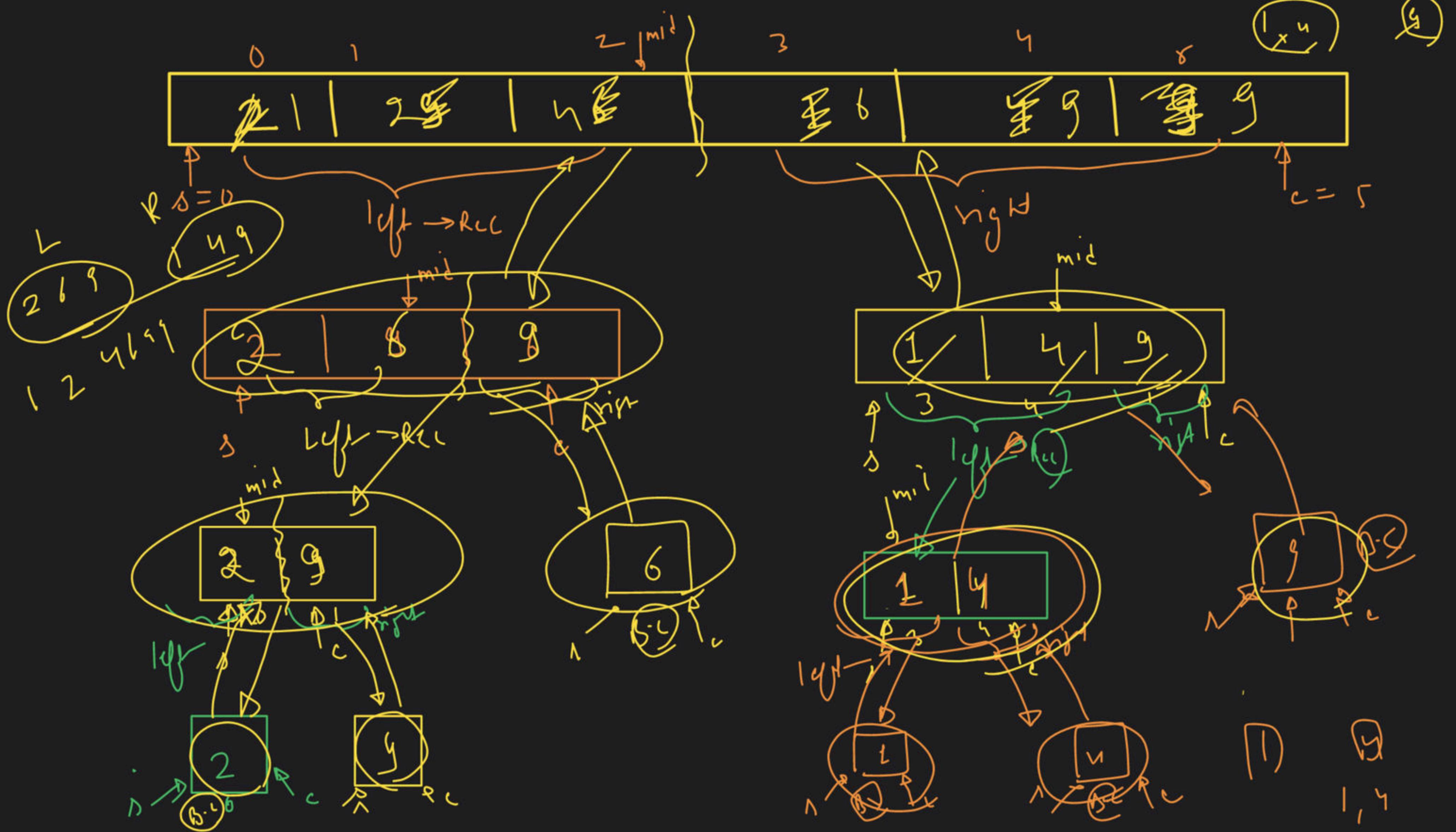
int mid = (s + e) / 2;

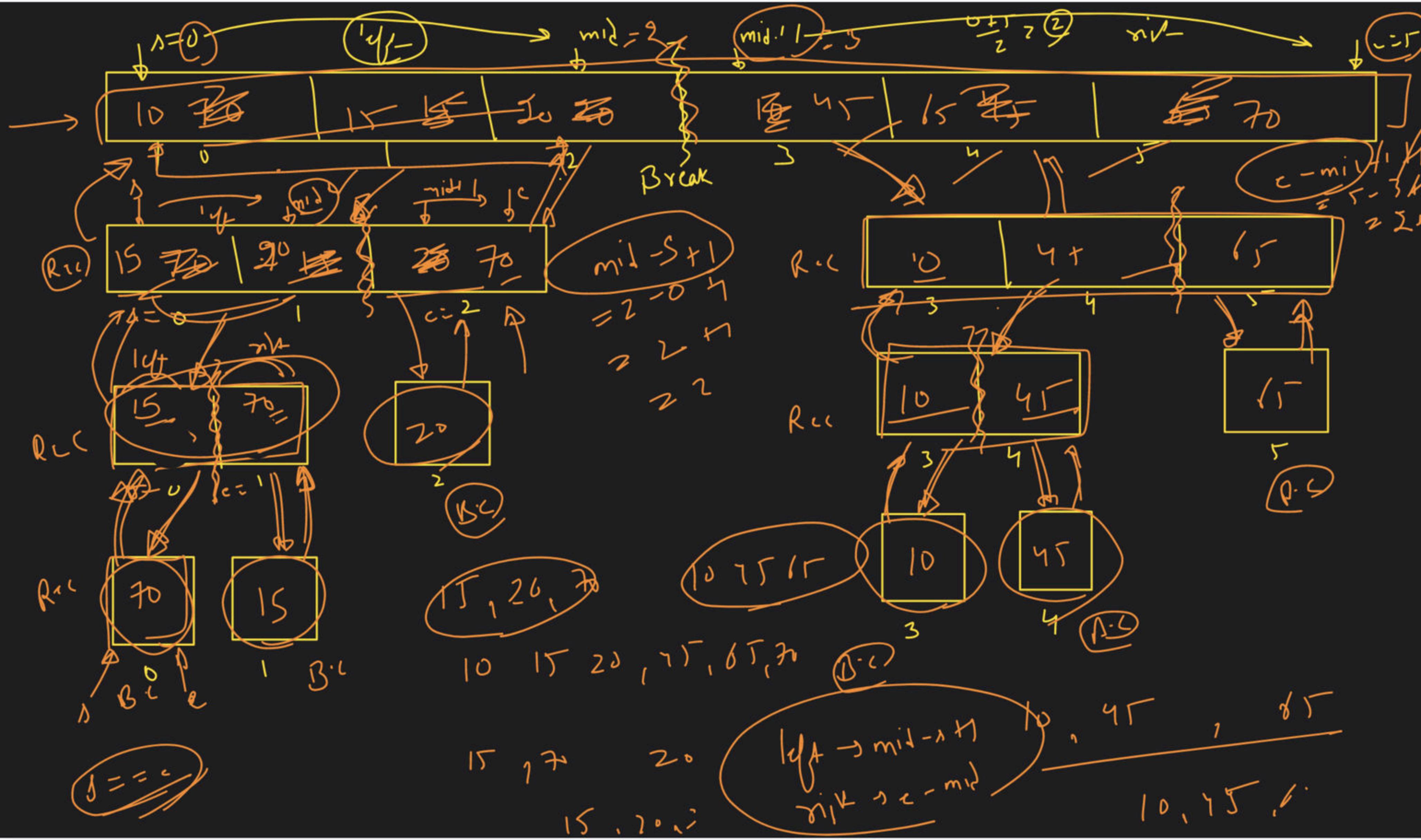
→ mergeSort (arr, s, mid);

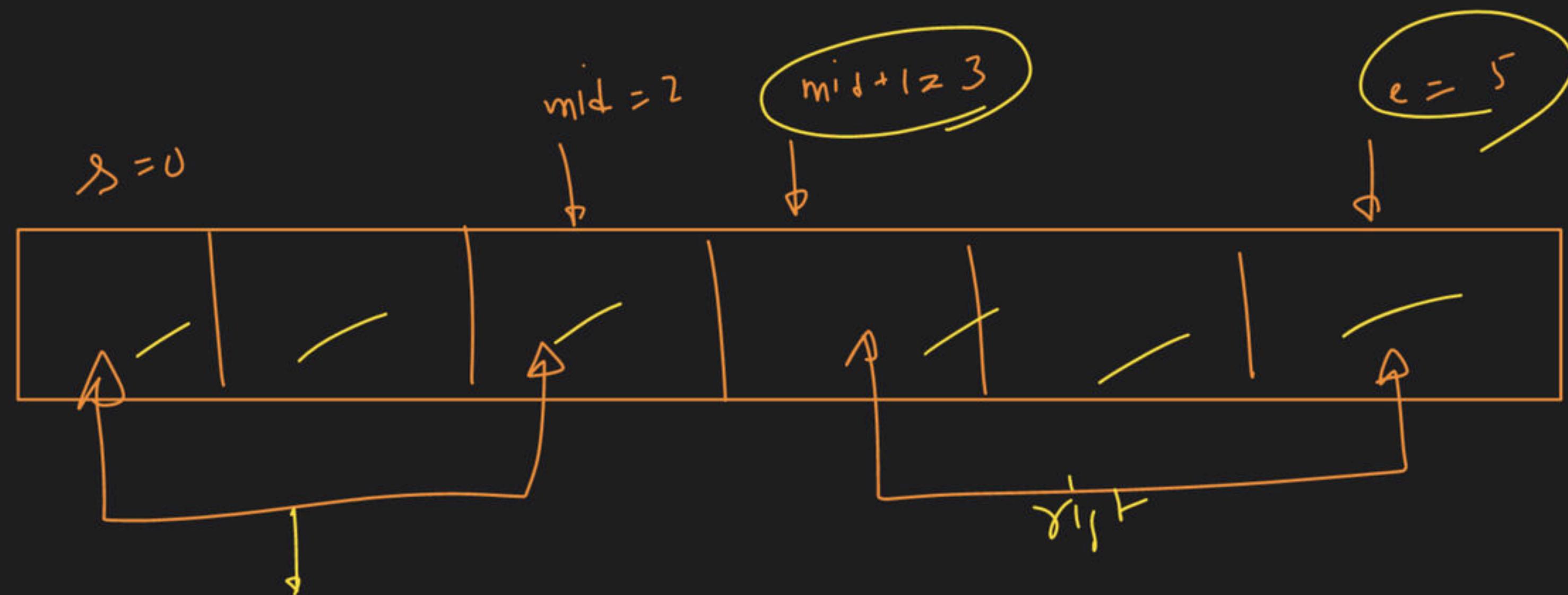
→ mergeSort (arr, mid + 1, e);

→ merge (arr, s, e, mid);

}



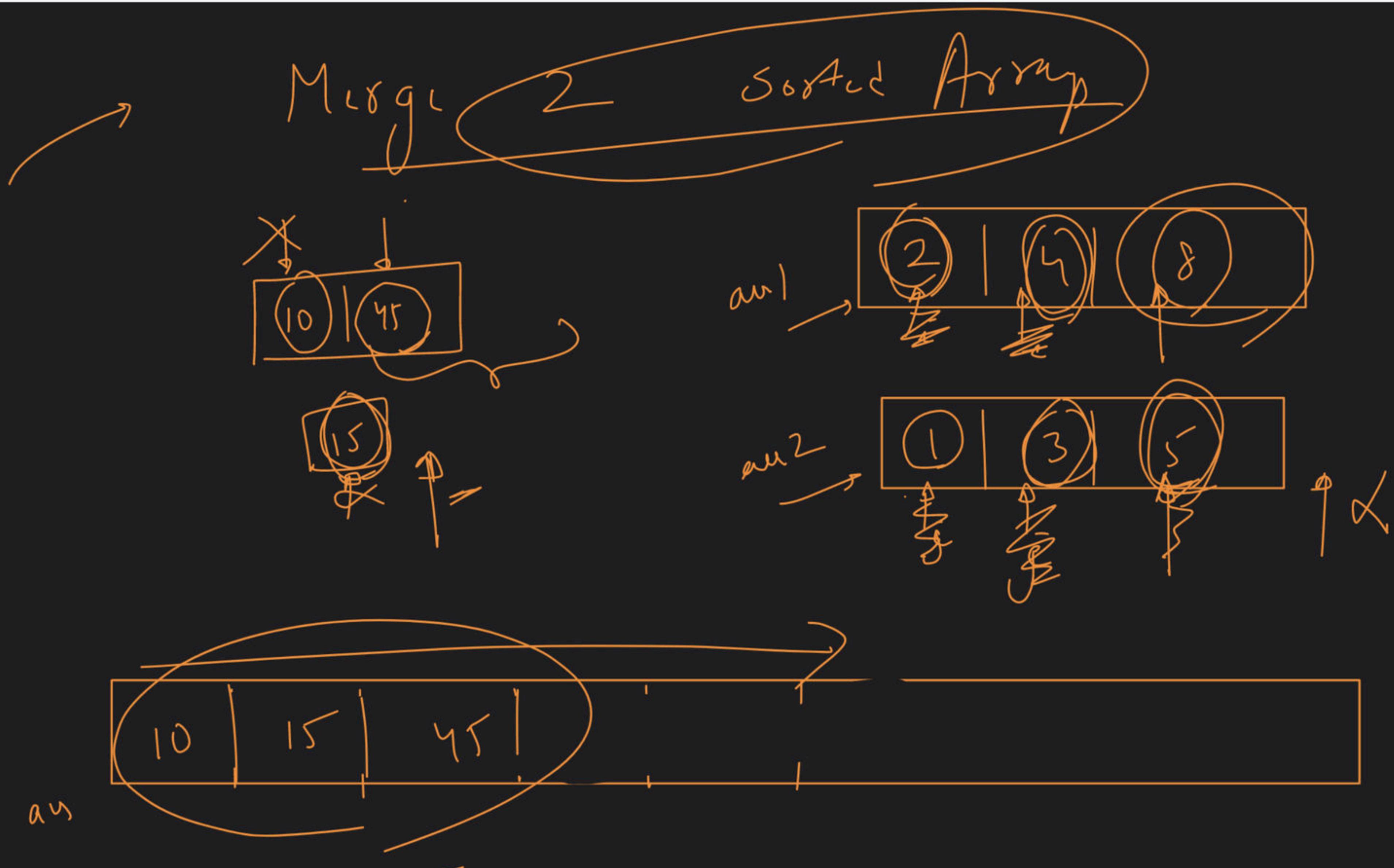


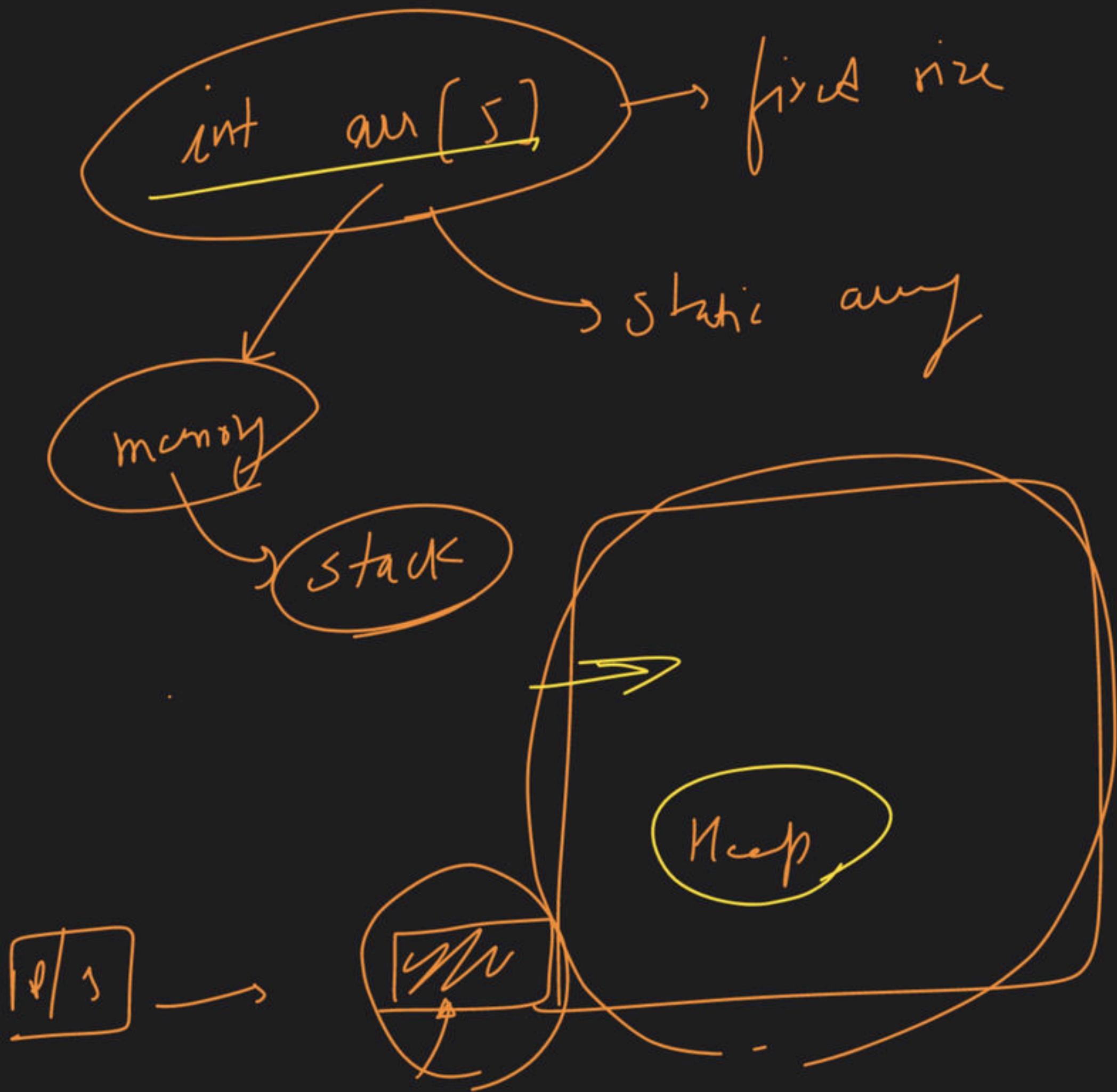
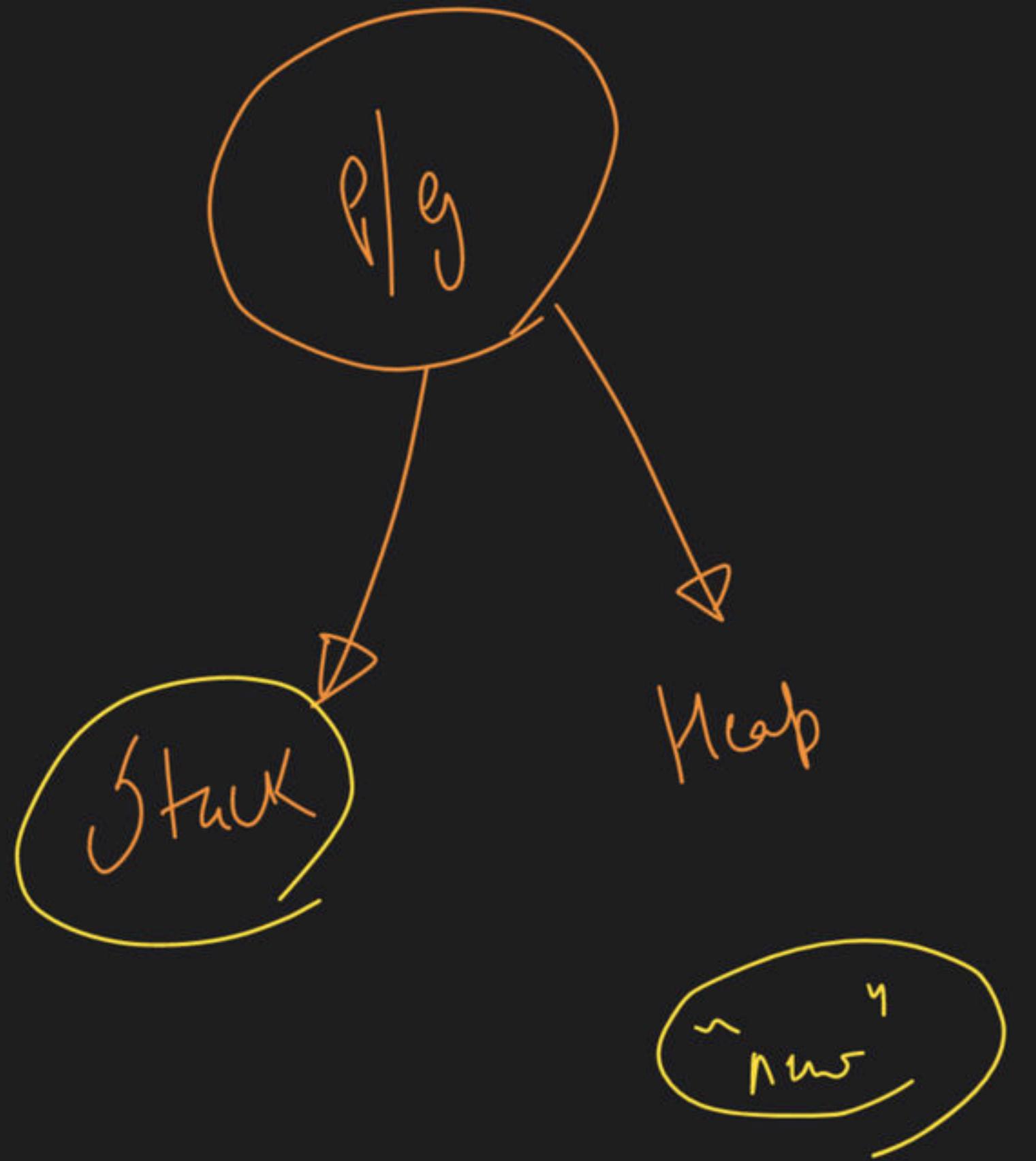


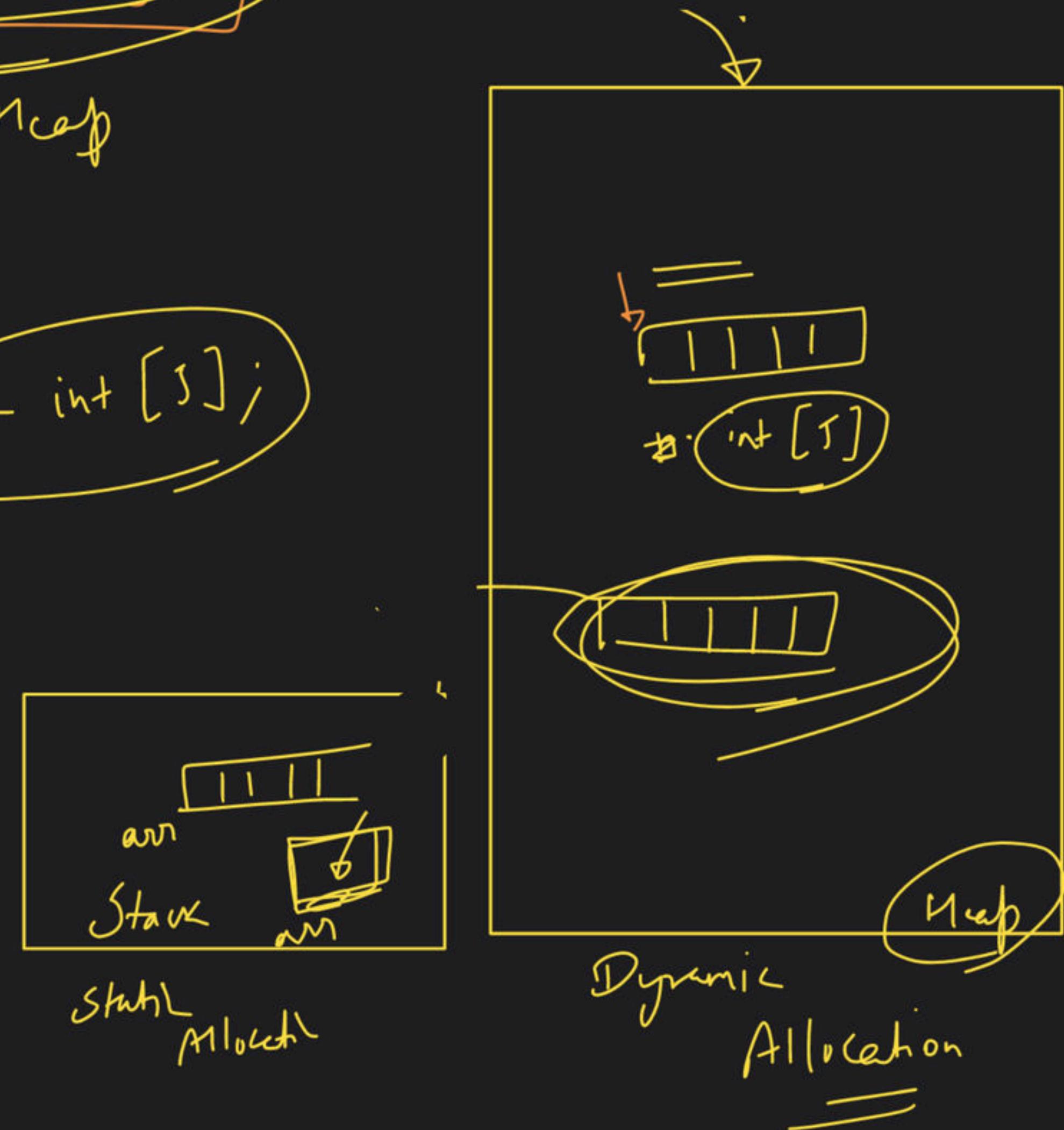
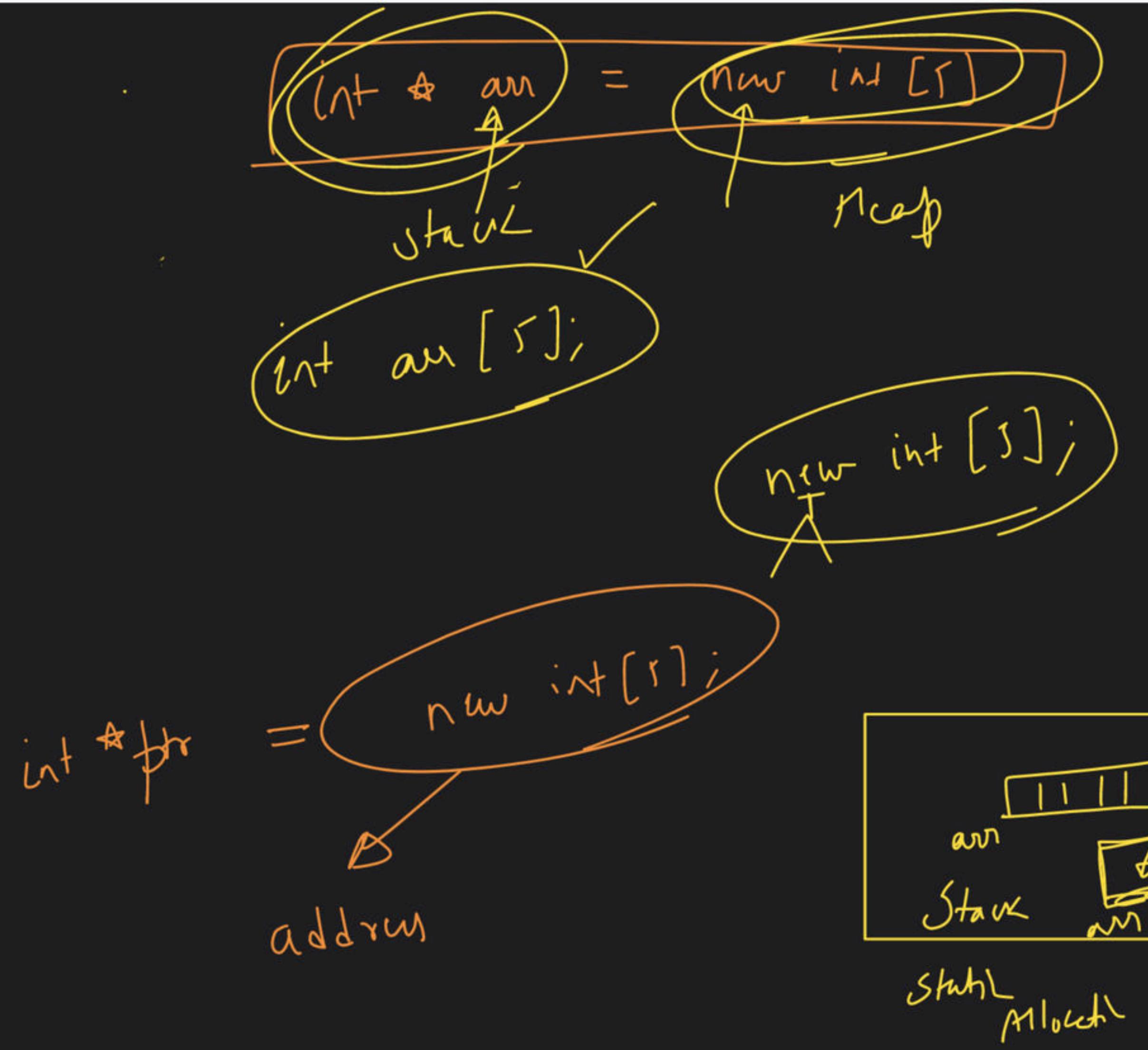
$$\begin{aligned} \text{len}^1 &:= \cancel{\text{mid} - 0 + 1} \\ &= 2 - 0 + 1 \\ &= 3 \end{aligned}$$

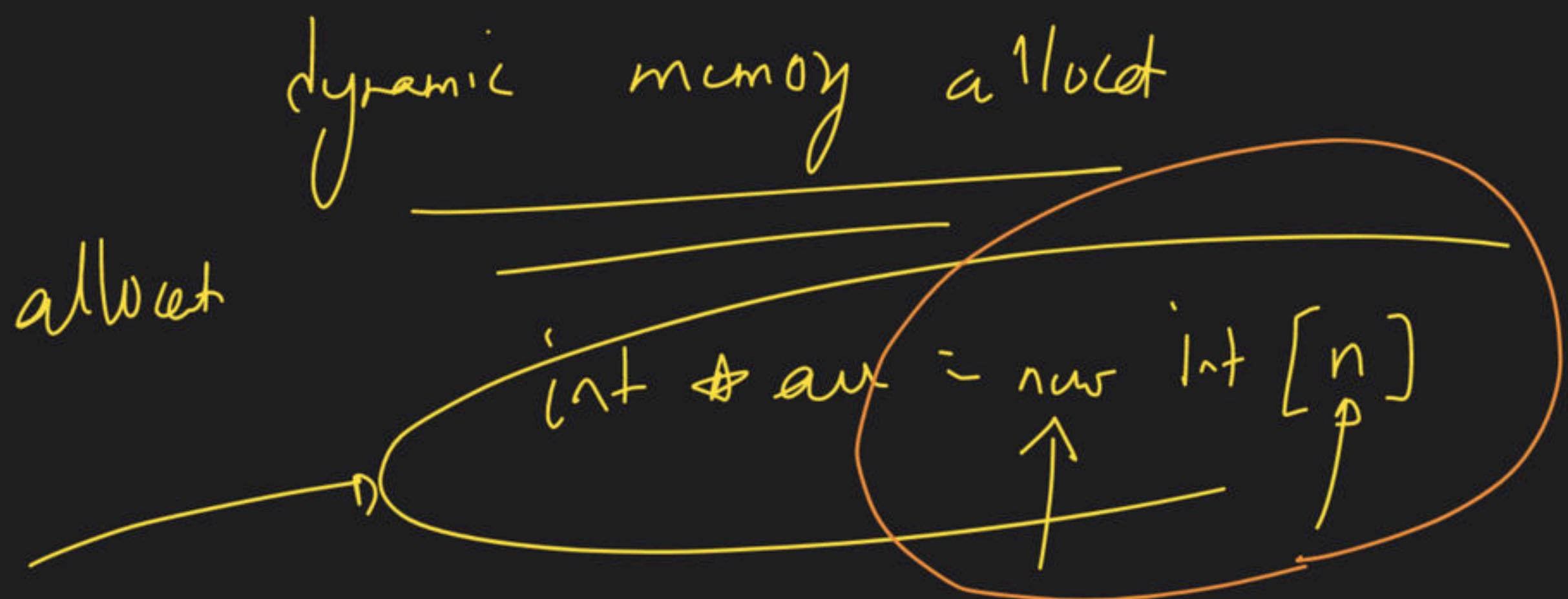
$$\begin{aligned} &= \frac{e - (\text{mid} + 1) + 1}{\cancel{j - i + 1}} = \cancel{e - mid}/\cancel{1} + 1 \\ &\Rightarrow 5 - 3 + 1 \\ &\quad - 2 + 1 \end{aligned}$$

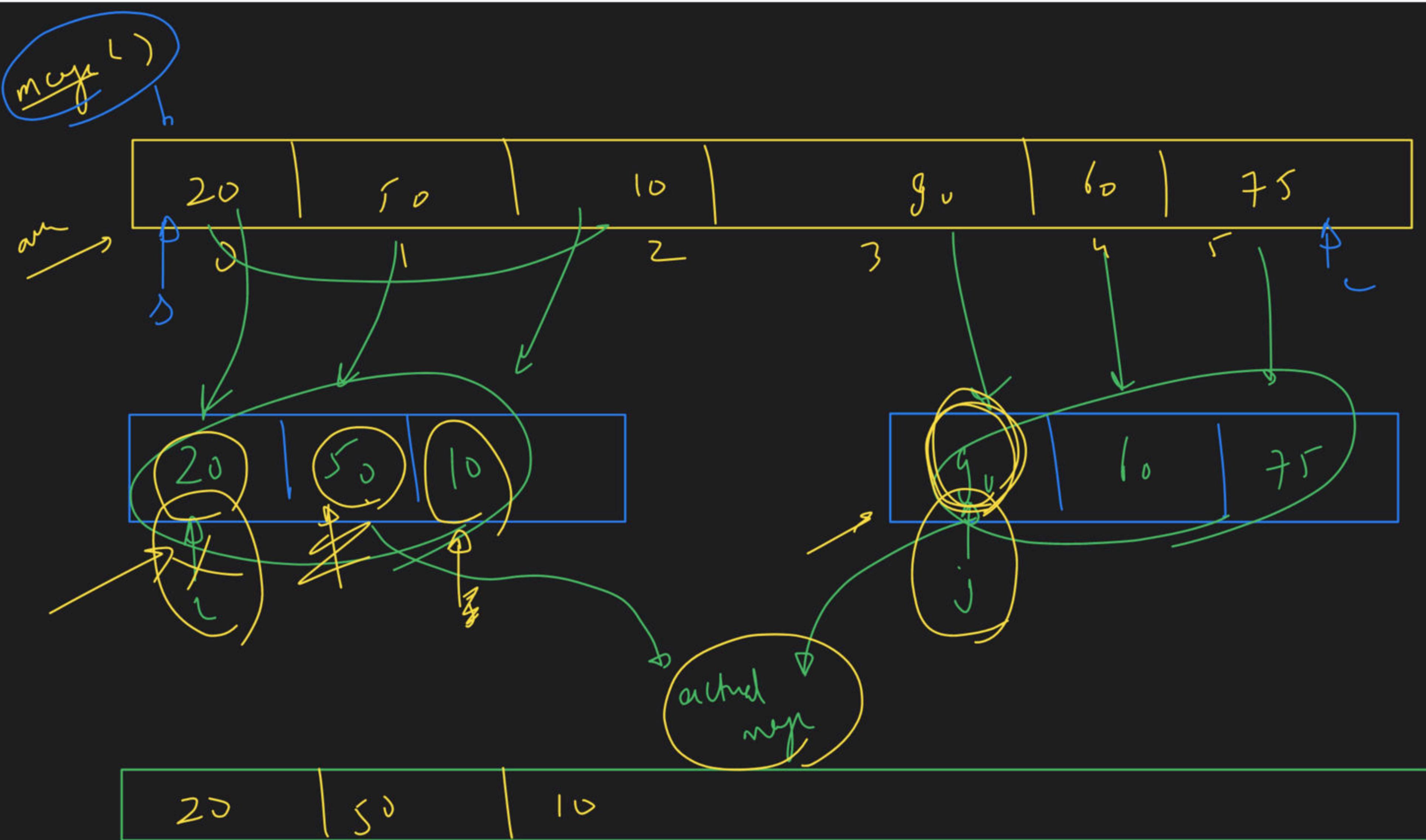
1un2

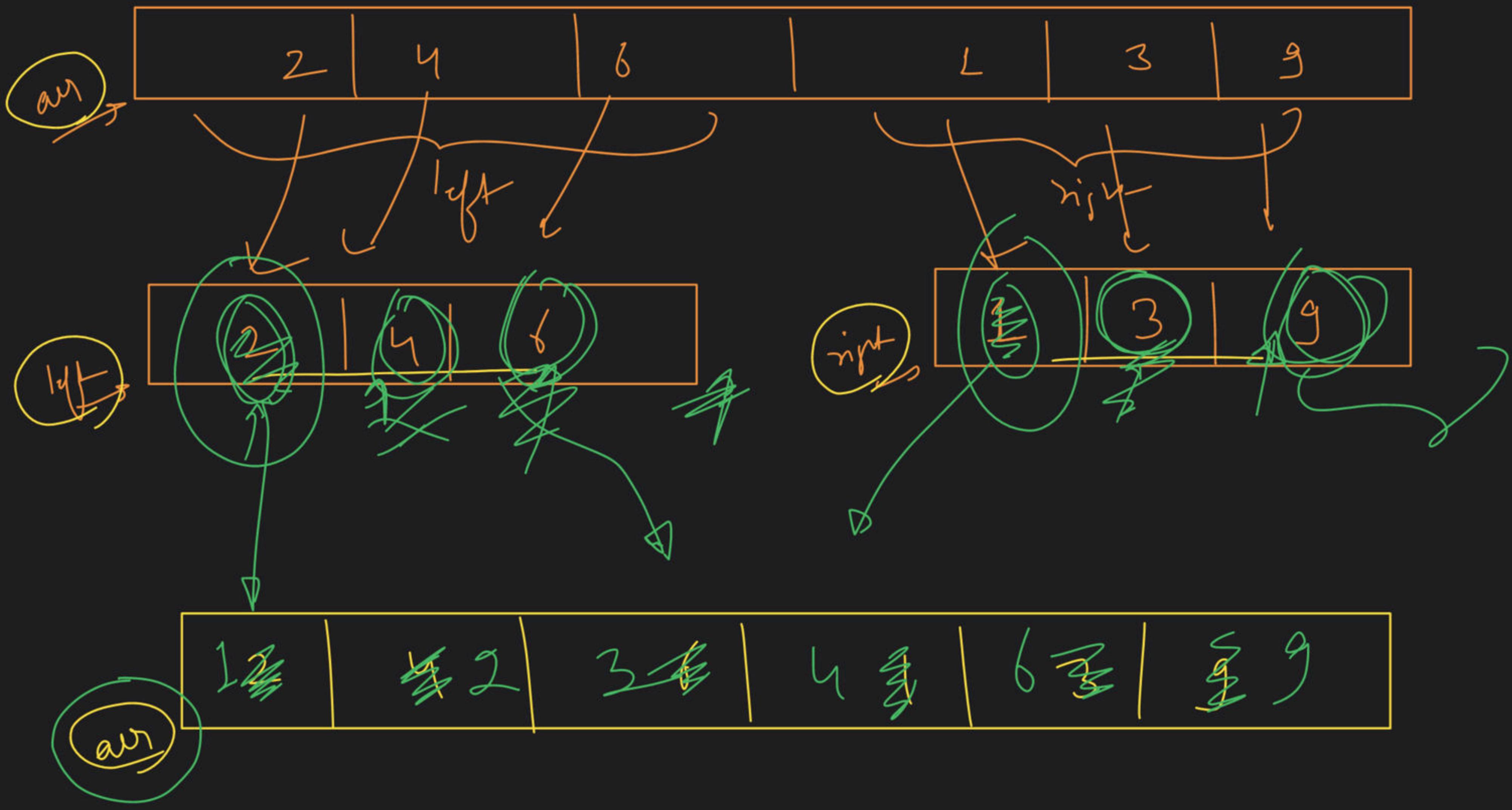


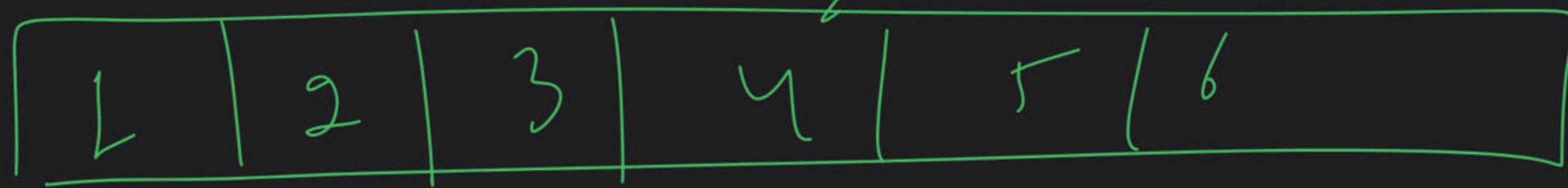
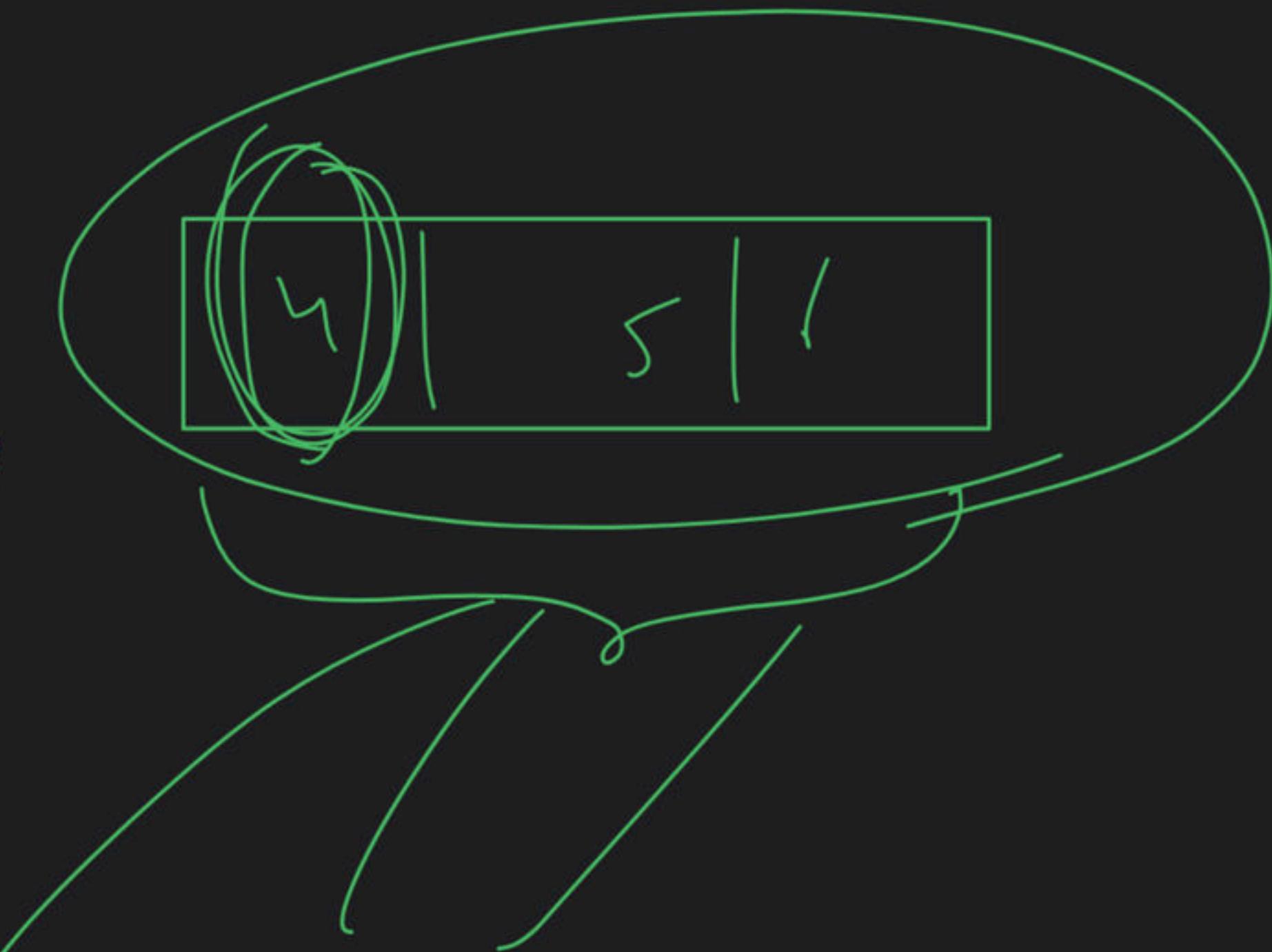
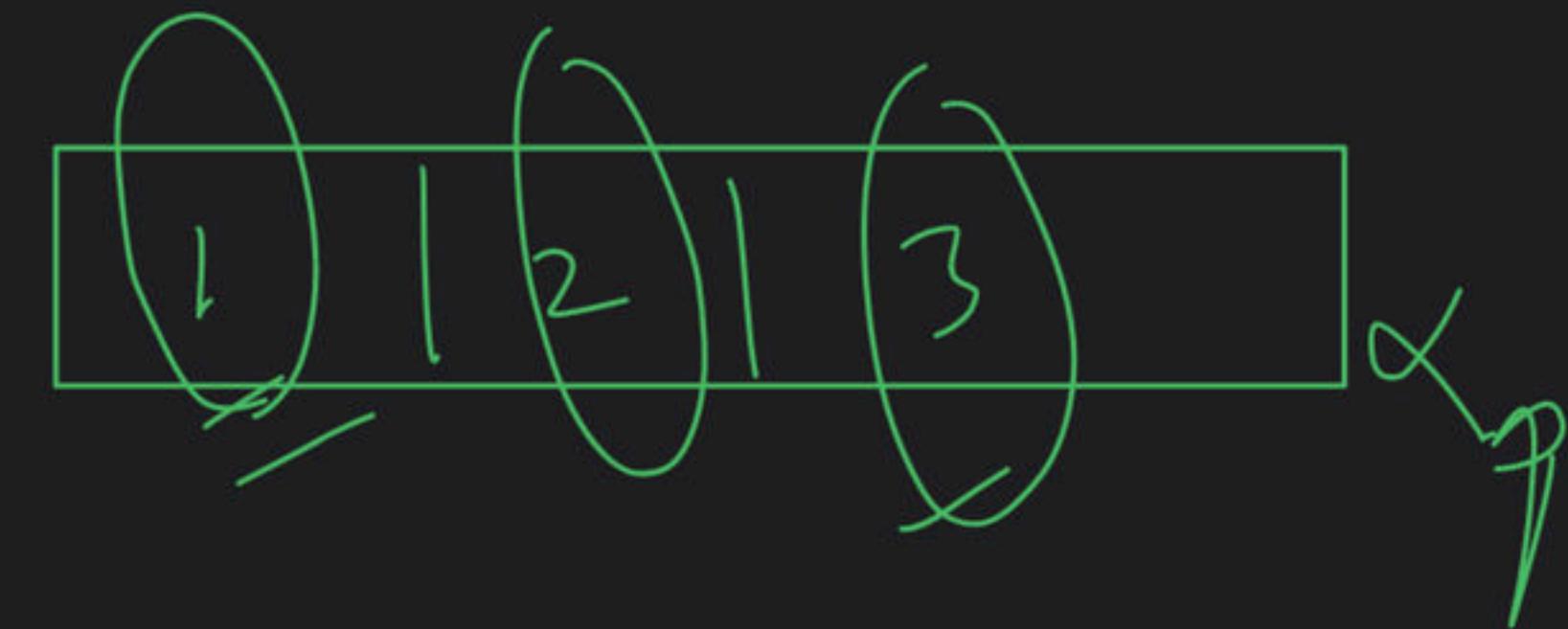












mergeSort (arr , s , e)

{

 // Base Case

 → Break into L & R

 → Recur for L & R

 → Merge L & R

}

 ↓
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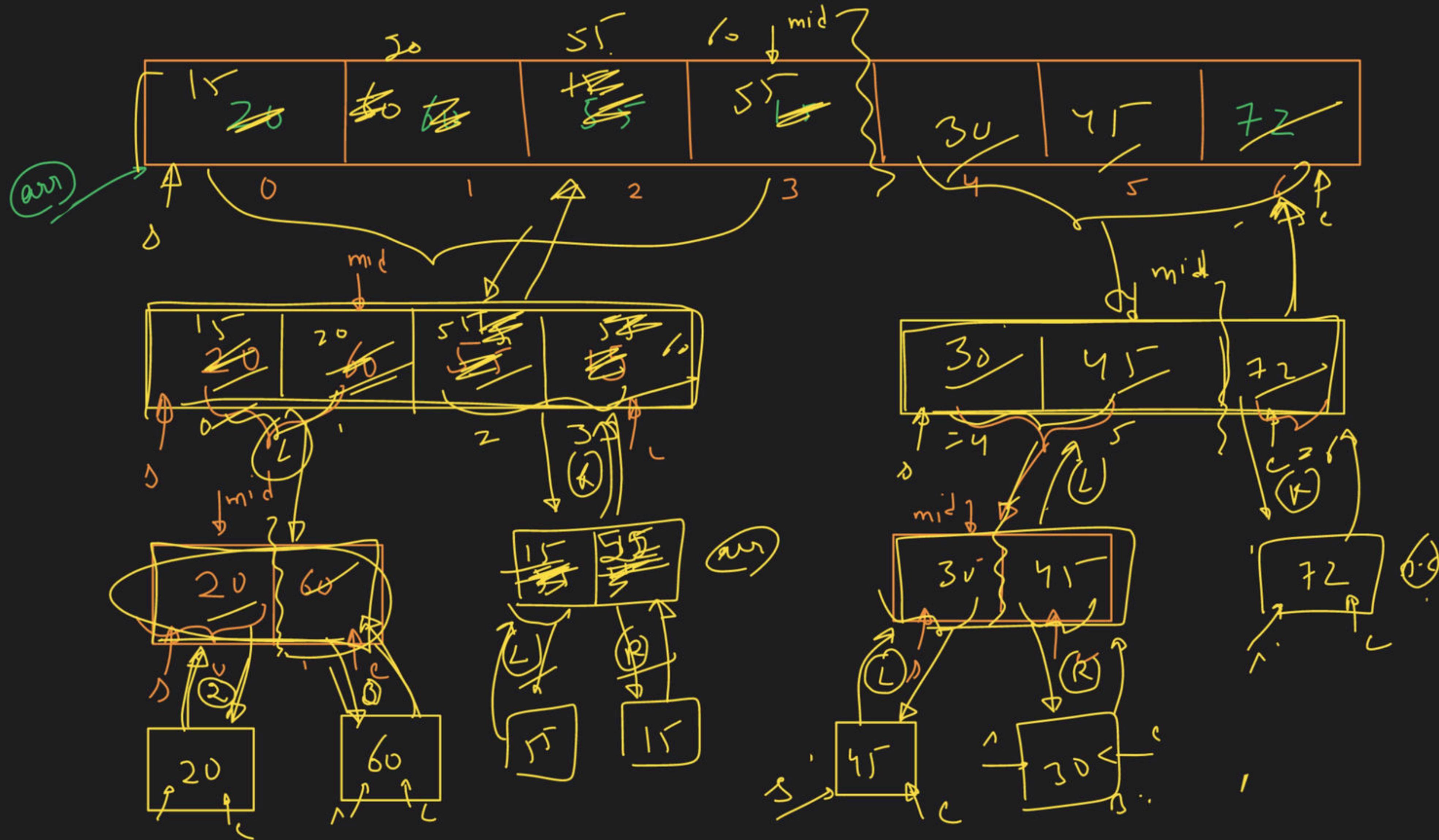
merge (arr , s , e , mid)

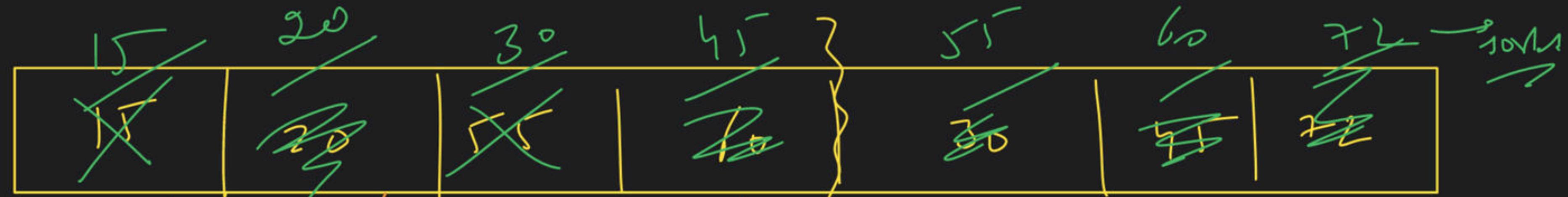
 → Create left & right arrays

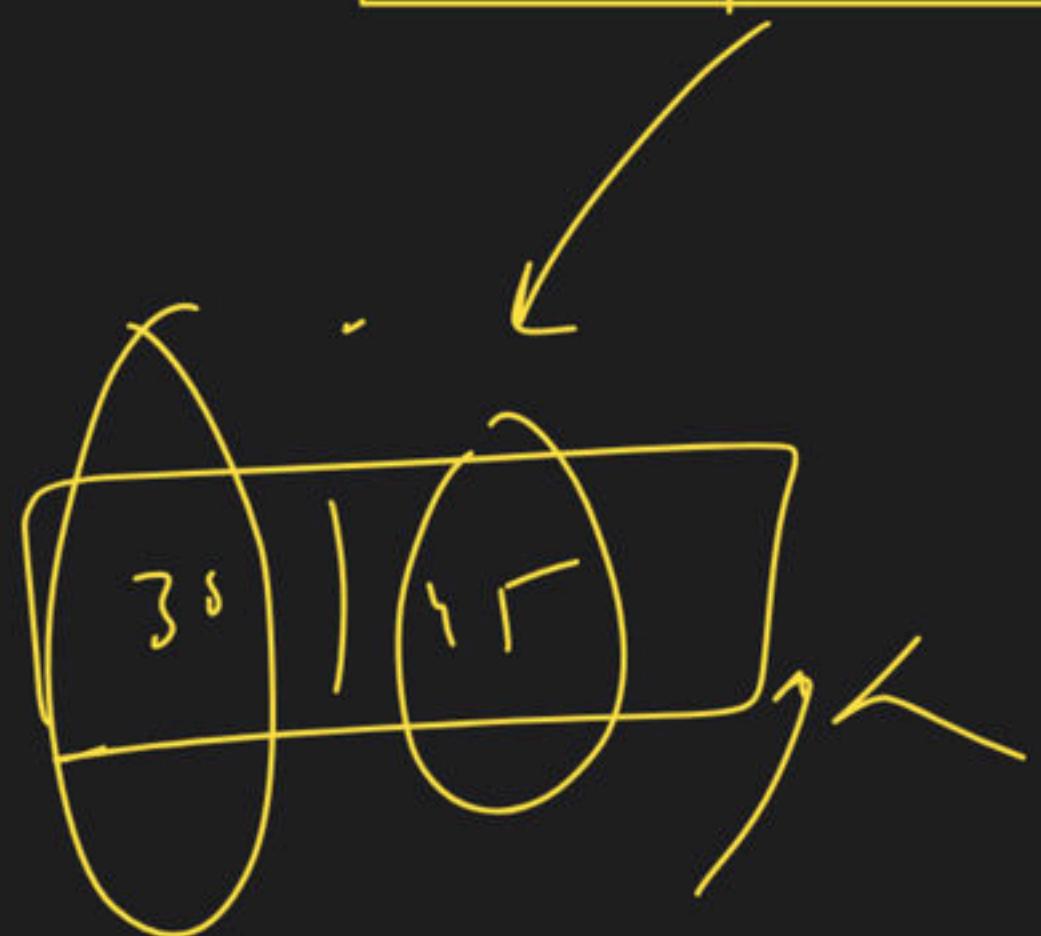
 → copy values from actual array
 into left & right array

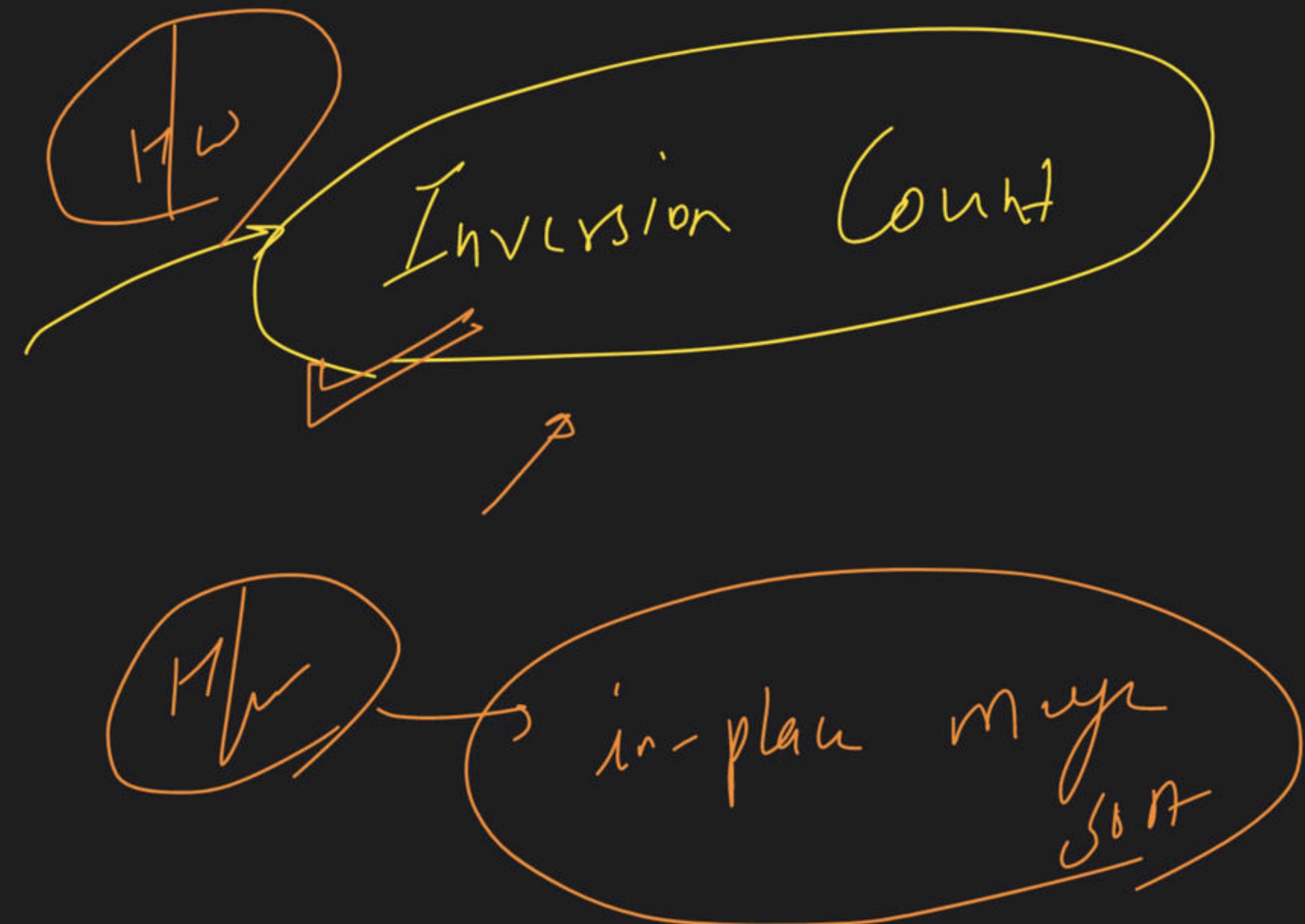
 → actual merge 2 sorted
 array (using 2 pointers)

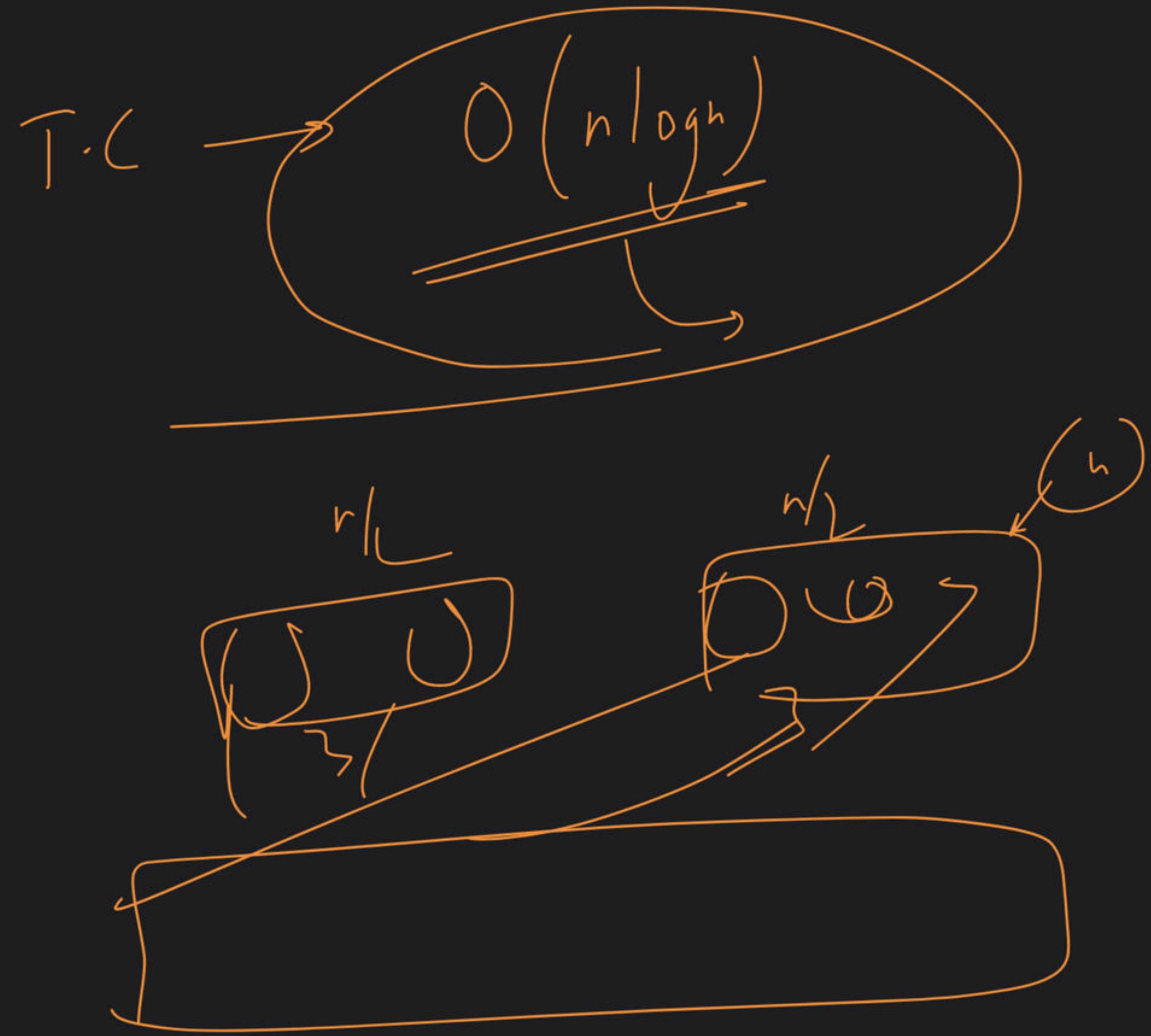
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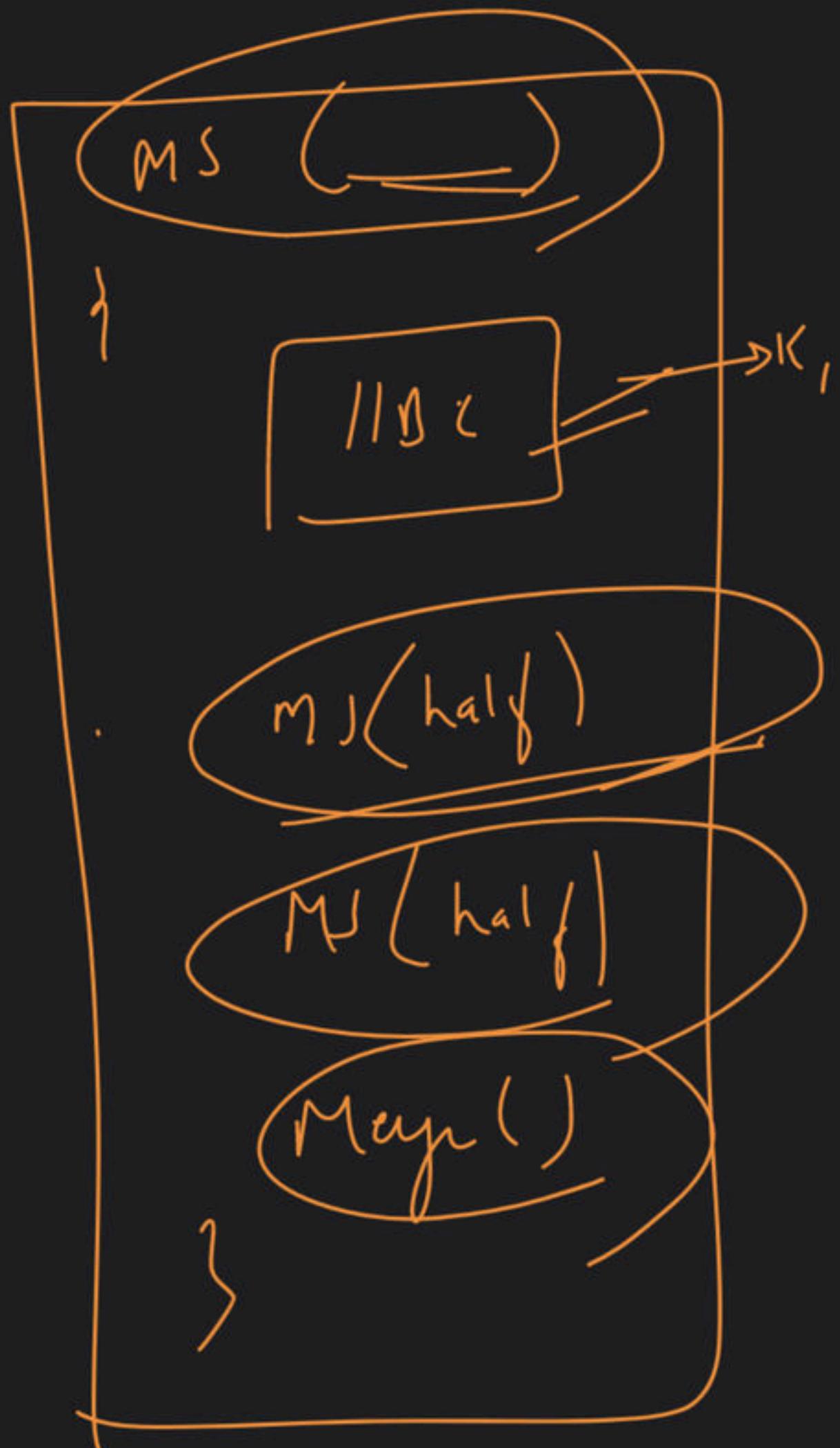












$$\underline{T(n)} = K_1 + T\left(\frac{n}{2}\right) + T\left(\frac{n}{4}\right) + n \star K$$

B.C
Q.u. Luft
Rpt R.c
Maye

$$T(n) = K_1 - 2T\left(\frac{n}{2}\right) + n \star K$$

$$2T\left(\frac{n}{2}\right) = 2K_1 + 4T\left(\frac{n}{4}\right) + n \star K$$

$$4T\left(\frac{n}{4}\right) = 4K_1 + 8T\left(\frac{n}{8}\right) + n \star K$$

$$8T\left(\frac{n}{8}\right) = 8K_1 + 16T\left(\frac{n}{16}\right) + n \star K$$

$$16T\left(\frac{n}{16}\right) = 16K_1 + 32T\left(\frac{n}{32}\right) + n \star K$$

$$32T\left(\frac{n}{32}\right) = 32K_1 + 64T\left(\frac{n}{64}\right) + n \star K$$

$$64T\left(\frac{n}{64}\right) = 64K_1 + 128T\left(\frac{n}{128}\right) + n \star K$$

$$128T\left(\frac{n}{128}\right) = 128K_1 + 256T\left(\frac{n}{256}\right) + n \star K$$

$$256T\left(\frac{n}{256}\right) = 256K_1 + 512T\left(\frac{n}{512}\right) + n \star K$$

$$512T\left(\frac{n}{512}\right) = 512K_1 + 1024T\left(\frac{n}{1024}\right) + n \star K$$

$$1024T\left(\frac{n}{1024}\right) = 1024K_1 + 2048T\left(\frac{n}{2048}\right) + n \star K$$

$$2048T\left(\frac{n}{2048}\right) = 2048K_1 + 4096T\left(\frac{n}{4096}\right) + n \star K$$

$$4096T\left(\frac{n}{4096}\right) = 4096K_1 + 8192T\left(\frac{n}{8192}\right) + n \star K$$

$$8192T\left(\frac{n}{8192}\right) = 8192K_1 + 16384T\left(\frac{n}{16384}\right) + n \star K$$

$$16384T\left(\frac{n}{16384}\right) = 16384K_1 + 32768T\left(\frac{n}{32768}\right) + n \star K$$

$$32768T\left(\frac{n}{32768}\right) = 32768K_1 + 65536T\left(\frac{n}{65536}\right) + n \star K$$

$$65536T\left(\frac{n}{65536}\right) = 65536K_1 + 131072T\left(\frac{n}{131072}\right) + n \star K$$

$$131072T\left(\frac{n}{131072}\right) = 131072K_1 + 262144T\left(\frac{n}{262144}\right) + n \star K$$

$$262144T\left(\frac{n}{262144}\right) = 262144K_1 + 524288T\left(\frac{n}{524288}\right) + n \star K$$

$$524288T\left(\frac{n}{524288}\right) = 524288K_1 + 1048576T\left(\frac{n}{1048576}\right) + n \star K$$

$$1048576T\left(\frac{n}{1048576}\right) = 1048576K_1 + 2097152T\left(\frac{n}{2097152}\right) + n \star K$$

$$2097152T\left(\frac{n}{2097152}\right) = 2097152K_1 + 4194304T\left(\frac{n}{4194304}\right) + n \star K$$

$$4194304T\left(\frac{n}{4194304}\right) = 4194304K_1 + 8388608T\left(\frac{n}{8388608}\right) + n \star K$$

$$8388608T\left(\frac{n}{8388608}\right) = 8388608K_1 + 16777216T\left(\frac{n}{16777216}\right) + n \star K$$

$$16777216T\left(\frac{n}{16777216}\right) = 16777216K_1 + 33554432T\left(\frac{n}{33554432}\right) + n \star K$$

$$33554432T\left(\frac{n}{33554432}\right) = 33554432K_1 + 67108864T\left(\frac{n}{67108864}\right) + n \star K$$

$$67108864T\left(\frac{n}{67108864}\right) = 67108864K_1 + 134217728T\left(\frac{n}{134217728}\right) + n \star K$$

$$134217728T\left(\frac{n}{134217728}\right) = 134217728K_1 + 268435456T\left(\frac{n}{268435456}\right) + n \star K$$

$$268435456T\left(\frac{n}{268435456}\right) = 268435456K_1 + 536870912T\left(\frac{n}{536870912}\right) + n \star K$$

$$536870912T\left(\frac{n}{536870912}\right) = 536870912K_1 + 1073741824T\left(\frac{n}{1073741824}\right) + n \star K$$

$$1073741824T\left(\frac{n}{1073741824}\right) = 1073741824K_1 + 2147483648T\left(\frac{n}{2147483648}\right) + n \star K$$

$$2147483648T\left(\frac{n}{2147483648}\right) = 2147483648K_1 + 4294967296T\left(\frac{n}{4294967296}\right) + n \star K$$

$$4294967296T\left(\frac{n}{4294967296}\right) = 4294967296K_1 + 8589934592T\left(\frac{n}{8589934592}\right) + n \star K$$

$$8589934592T\left(\frac{n}{8589934592}\right) = 8589934592K_1 + 17179869184T\left(\frac{n}{17179869184}\right) + n \star K$$

$$17179869184T\left(\frac{n}{17179869184}\right) = 17179869184K_1 + 34359738368T\left(\frac{n}{34359738368}\right) + n \star K$$

$$34359738368T\left(\frac{n}{34359738368}\right) = 34359738368K_1 + 68719476736T\left(\frac{n}{68719476736}\right) + n \star K$$

$$68719476736T\left(\frac{n}{68719476736}\right) = 68719476736K_1 + 137438953472T\left(\frac{n}{137438953472}\right) + n \star K$$

$$137438953472T\left(\frac{n}{137438953472}\right) = 137438953472K_1 + 274877906944T\left(\frac{n}{274877906944}\right) + n \star K$$

$$274877906944T\left(\frac{n}{274877906944}\right) = 274877906944K_1 + 549755813888T\left(\frac{n}{549755813888}\right) + n \star K$$

$$549755813888T\left(\frac{n}{549755813888}\right) = 549755813888K_1 + 1099511627776T\left(\frac{n}{1099511627776}\right) + n \star K$$

$$1099511627776T\left(\frac{n}{1099511627776}\right) = 1099511627776K_1 + 2199023255552T\left(\frac{n}{2199023255552}\right) + n \star K$$

$$2199023255552T\left(\frac{n}{2199023255552}\right) = 2199023255552K_1 + 4398046511104T\left(\frac{n}{4398046511104}\right) + n \star K$$

$$4398046511104T\left(\frac{n}{4398046511104}\right) = 4398046511104K_1 + 8796093022208T\left(\frac{n}{8796093022208}\right) + n \star K$$

$$8796093022208T\left(\frac{n}{8796093022208}\right) = 8796093022208K_1 + 17592186044416T\left(\frac{n}{17592186044416}\right) + n \star K$$

$$17592186044416T\left(\frac{n}{17592186044416}\right) = 17592186044416K_1 + 35184372088832T\left(\frac{n}{35184372088832}\right) + n \star K$$

$$35184372088832T\left(\frac{n}{35184372088832}\right) = 35184372088832K_1 + 70368744177664T\left(\frac{n}{70368744177664}\right) + n \star K$$

$$70368744177664T\left(\frac{n}{70368744177664}\right) = 70368744177664K_1 + 140737488355328T\left(\frac{n}{140737488355328}\right) + n \star K$$

$$140737488355328T\left(\frac{n}{140737488355328}\right) = 140737488355328K_1 + 281474976710656T\left(\frac{n}{281474976710656}\right) + n \star K$$

$$281474976710656T\left(\frac{n}{281474976710656}\right) = 281474976710656K_1 + 562949953421312T\left(\frac{n}{562949953421312}\right) + n \star K$$

$$562949953421312T\left(\frac{n}{562949953421312}\right) = 562949953421312K_1 + 1125899906842624T\left(\frac{n}{1125899906842624}\right) + n \star K$$

$$1125899906842624T\left(\frac{n}{1125899906842624}\right) = 1125899906842624K_1 + 2251799813685248T\left(\frac{n}{2251799813685248}\right) + n \star K$$

$$2251799813685248T\left(\frac{n}{2251799813685248}\right) = 2251799813685248K_1 + 4503599627370496T\left(\frac{n}{4503599627370496}\right) + n \star K$$

$$4503599627370496T\left(\frac{n}{4503599627370496}\right) = 4503599627370496K_1 + 9007199254740992T\left(\frac{n}{9007199254740992}\right) + n \star K$$

$$9007199254740992T\left(\frac{n}{9007199254740992}\right) = 9007199254740992K_1 + 18014398509481984T\left(\frac{n}{18014398509481984}\right) + n \star K$$

$$18014398509481984T\left(\frac{n}{18014398509481984}\right) = 18014398509481984K_1 + 36028797018963968T\left(\frac{n}{36028797018963968}\right) + n \star K$$

$$36028797018963968T\left(\frac{n}{36028797018963968}\right) = 36028797018963968K_1 + 72057594037927936T\left(\frac{n}{72057594037927936}\right) + n \star K$$

$$72057594037927936T\left(\frac{n}{72057594037927936}\right) = 72057594037927936K_1 + 144115188075855872T\left(\frac{n}{144115188075855872}\right) + n \star K$$

$$144115188075855872T\left(\frac{n}{144115188075855872}\right) = 144115188075855872K_1 + 288230376151711744T\left(\frac{n}{288230376151711744}\right) + n \star K$$

$$288230376151711744T\left(\frac{n}{288230376151711744}\right) = 288230376151711744K_1 + 576460752303423488T\left(\frac{n}{576460752303423488}\right) + n \star K$$

$$576460752303423488T\left(\frac{n}{576460752303423488}\right) = 576460752303423488K_1 + 1152921504606846976T\left(\frac{n}{1152921504606846976}\right) + n \star K$$

$$1152921504606846976T\left(\frac{n}{1152921504606846976}\right) = 1152921504606846976K_1 + 2305843009213693952T\left(\frac{n}{2305843009213693952}\right) + n \star K$$

$$2305843009213693952T\left(\frac{n}{2305843009213693952}\right) = 2305843009213693952K_1 + 4611686018427387904T\left(\frac{n}{4611686018427387904}\right) + n \star K$$

$$4611686018427387904T\left(\frac{n}{4611686018427387904}\right) = 4611686018427387904K_1 + 9223372036854775808T\left(\frac{n}{9223372036854775808}\right) + n \star K$$

$$9223372036854775808T\left(\frac{n}{9223372036854775808}\right) = 9223372036854775808K_1 + 18446744073709551616T\left(\frac{n}{18446744073709551616}\right) + n \star K$$

$$18446744073709551616T\left(\frac{n}{18446744073709551616}\right) = 18446744073709551616K_1 + 36893488147419103232T\left(\frac{n}{36893488147419103232}\right) + n \star K$$

$$36893488147419103232T\left(\frac{n}{36893488147419103232}\right) = 36893488147419103232K_1 + 73786976294838206464T\left(\frac{n}{73786976294838206464}\right) + n \star K$$

$$73786976294838206464T\left(\frac{n}{73786976294838206464}\right) = 73786976294838206464K_1 + 147573952589676412928T\left(\frac{n}{147573952589676412928}\right) + n \star K$$

$$147573952589676412928T\left(\frac{n}{147573952589676412928}\right) = 147573952589676412928K_1 + 295147905179352825856T\left(\frac{n}{295147905179352825856}\right) + n \star K$$

$$295147905179352825856T\left(\frac{n}{295147905179352825856}\right) = 295147905179352825856K_1 + 590295810358705651712T\left(\frac{n}{590295810358705651712}\right) + n \star K$$

$$590295810358705651712T\left(\frac{n}{590295810358705651712}\right) = 590295810358705651712K_1 + 1180591620717411303424T\left(\frac{n}{1180591620717411303424}\right) + n \star K$$

$$1180591620717411303424T\left(\frac{n}{1180591620717411303424}\right) = 1180591620717411303424K_1 + 2361183241434822606848T\left(\frac{n}{2361183241434822606848}\right) + n \star K$$

$$2361183241434822606848T\left(\frac{n}{2361183241434822606848}\right) = 2361183241434822606848K_1 + 4722366482869645213696T\left(\frac{n}{4722366482869645213696}\right) + n \star K$$

$$4722366482869645213696T\left(\frac{n}{4722366482869645213696}\right) = 4722366482869645213696K_1 + 9444732965739290427392T\left(\frac{n}{9444732965739290427392}\right) + n \star K$$

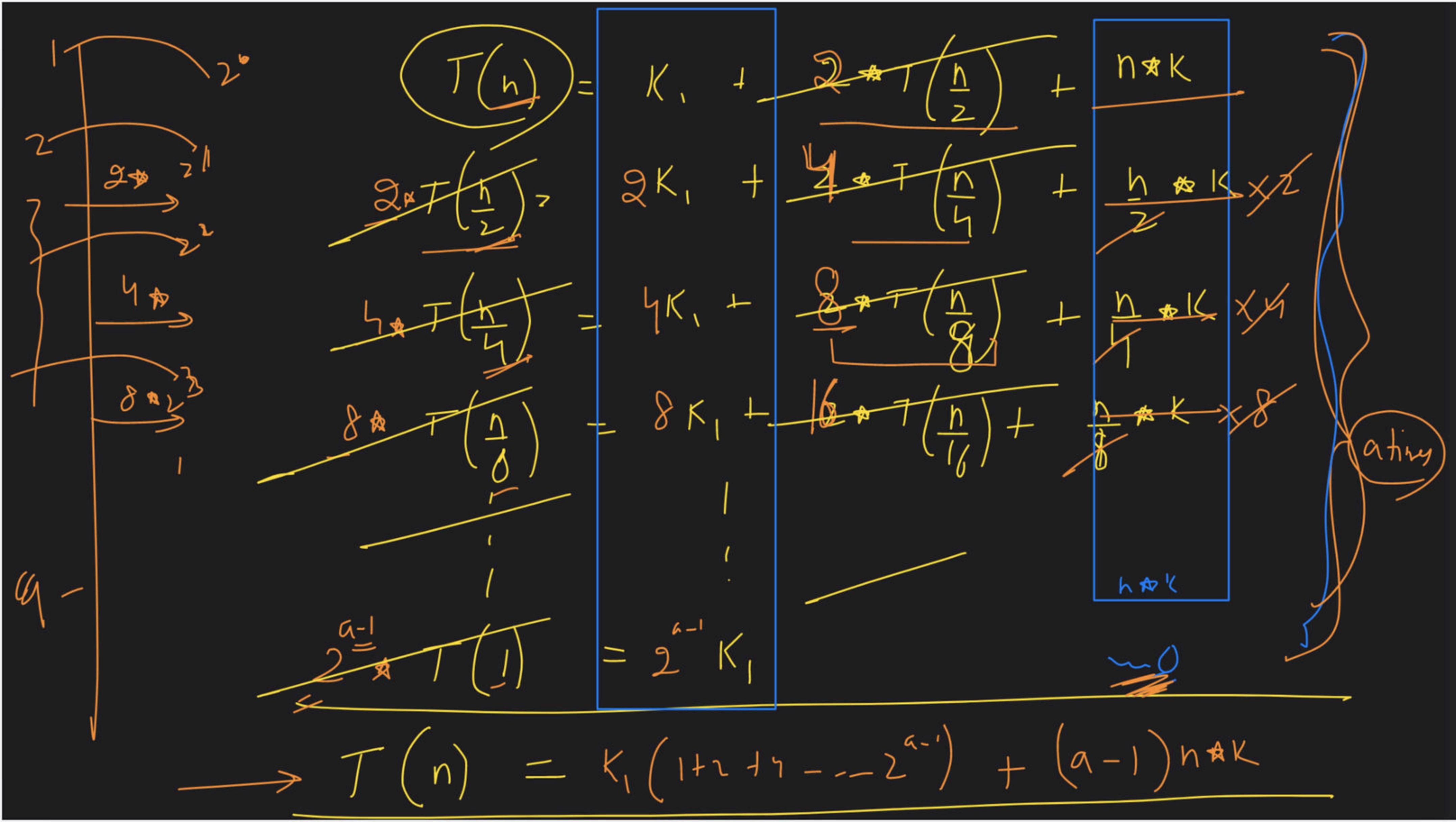
$$9444732965739290427392T\left(\frac{n}{9444732965739290427392}\right) = 9444732965739290427392K_1 + 18889465931478580854784T\left(\frac{n}{18889465931478580854784}\right) + n \star K$$

$$18889465931478580854784T\left(\frac{n}{18889465931478580854784}\right) = 18889465931478580854784K_1 + 37778931862957161709568T\left(\frac{n}{37778931862957161709568}\right) + n \star K$$

$$37778$$

$$T(n) = K_1 + T\left(\frac{n}{2}\right) + T\left(\frac{n}{2}\right) + n \cancel{*} K$$

$$T(n) = K_1 + 2T\left(\frac{n}{2}\right) + n \cancel{*} 1$$



$$T(n) \geq K_1 \left(1 + 2 + 4 + \dots + 2^{n-1} \right) + (n-1) \cancel{+ n \times k}$$

$$\geq nK_1 + a \times n \cancel{\times k}$$

$$= n \left(\cancel{K_1} + a \times k \right)$$

$$= n \times a \times \cancel{k}$$

$$\geq n \times a = \boxed{n \times \cancel{a}}$$

$$T(n) = K_1 \left(1 + 2 + 4 + \dots + 2^{n-1} \right) + (a-1)n \cancel{*} k$$

$\cancel{g \cdot p}$

$$= \underline{K_1 \times n} + \underline{a \cancel{*} n \cancel{*} k}$$

$$= K_1 n + \log a \times n \times k$$

$$\approx \cancel{K_1 n} + \cancel{n \log n \cancel{*} k} = n \log n \cancel{*} k$$

~~a~~ $\frac{(2^{\gamma-1})}{\gamma-1}$

$$\gamma - 1$$

$$1 \propto \frac{(2^{\gamma-1})}{\gamma-1}$$

~~2ⁿ~~

$$> 2^n \approx 2^{\log_2 n}$$

~~n~~

~~n log n~~

$n/2$

$n/2$

$n/2$

$n/2$

$n/2$

1

(a times)

$$a = \log n$$

