Lab8 Solution

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Lab8.A Closest

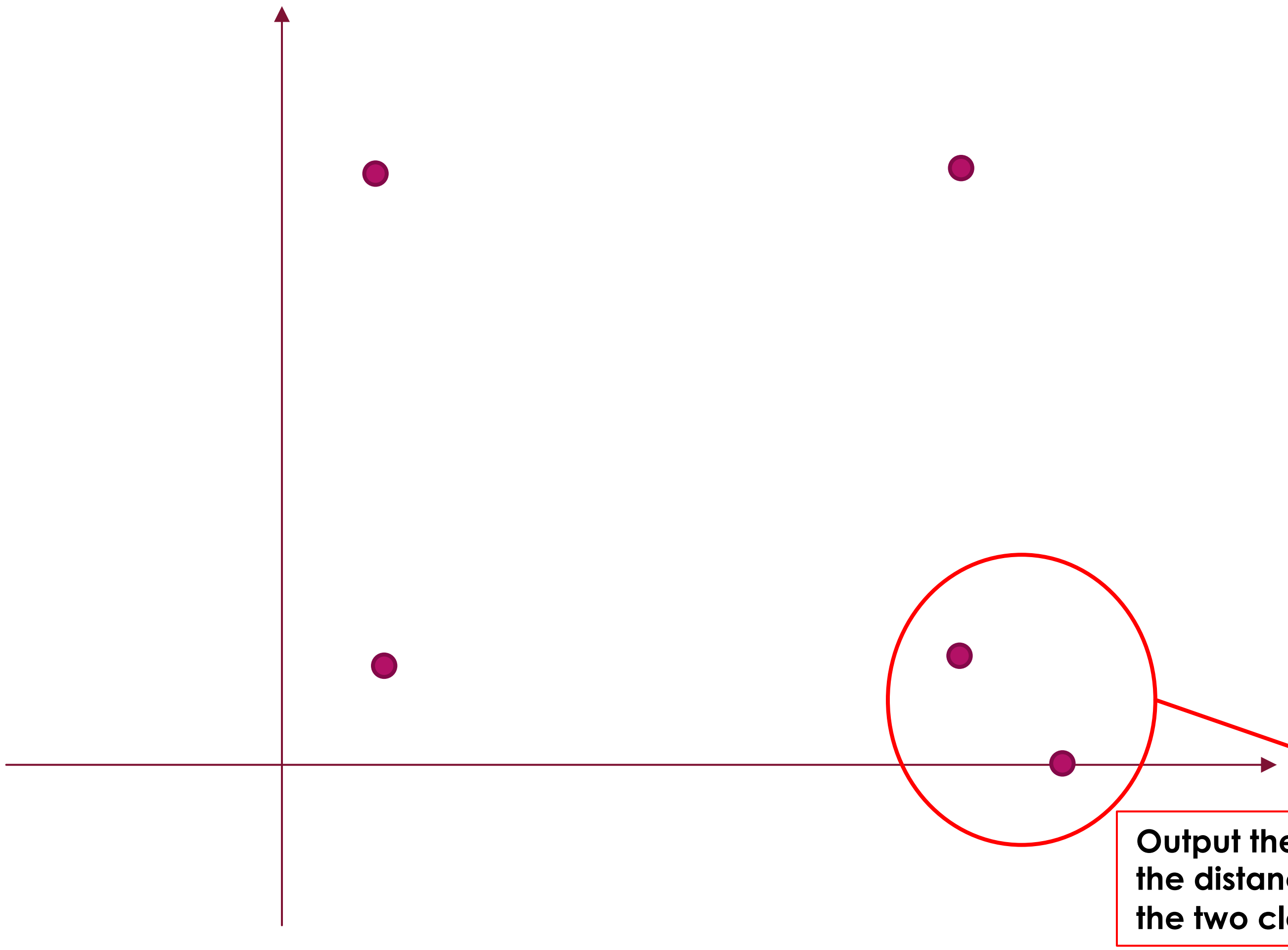
- Given n points on a two-dimensional plane, please find the closest pairs of points.

Input:

```
5
1 1
1 9
9 1
9 9
0 10
```

n: the number of points

(x_i, y_i): the coordinates of the i − th point



Output the square of the distance between the two closest points

Output:

2

Lecture: Page21~37, divide-and-conquer.pdf

Lab8.B Urban Construction(1)

- Sjkmost persuaded Justin to force his citizens to trip with zipline. However, the citizens are not strong enough and the citizens often fell from the zipline. Therefore, they decided to provide the citizens with some cable cars. Now Sjkmost is preparing the cable cars.
- There are n cable cars on the cable, each has an index a_i. **Sijmost** is trying to put them in order.
- Sjkmost can spend $c\ justin$ (a type of currency) to cut down a segment of rope of length c, rotate it and splice back. That is, he can spent $r - l + 1\ justin$ to rotate the cable cars in an interval [l,r].

Lab8.B Urban Construction(2)

- Sjkmost has a budget of 2×10^7 $justin$. He should sort the cable cars with some operations with a total cost no more than 2×10^7 $justin$. But he is so good at sorting that this problem is too boring for him.

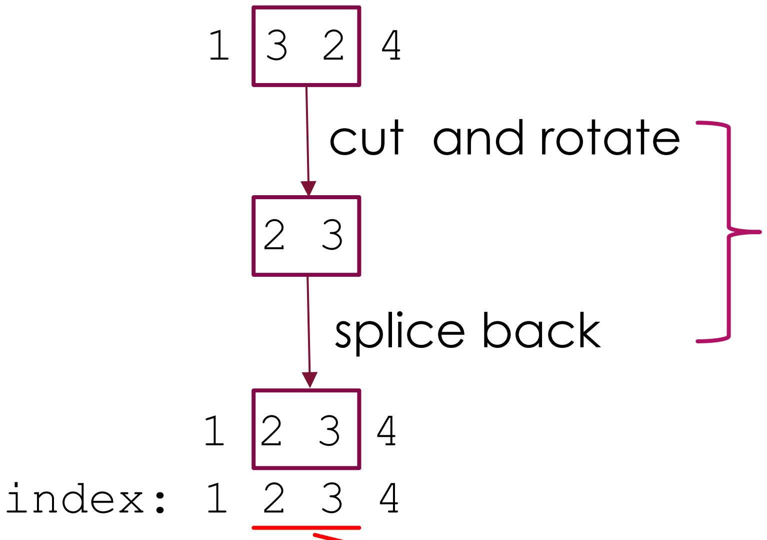
- Ihyyy, who is not good at graph theory at all and got lost in Justin's city, luckily met Justin at last. Now he doesn't know how to leave the city. If he can help sort the cable cars for Sjkmost, Sjkmost will tell him how to leave. However, Ihyyy is not good at sorting as well. Can you help him?

Sample Input1:

4 n

1 3 2 4

a_i



1 3 2 4

cut and rotate

2 3

splice back

1 2 3 4

index: 1 2 3 4

$spend\ 3 - 2 + 1 = 2\ justin$

$\boldsymbol{Total\ cost: 2 \leq 2 \times 10^7}$

$\boldsymbol{l_i, r_i}$

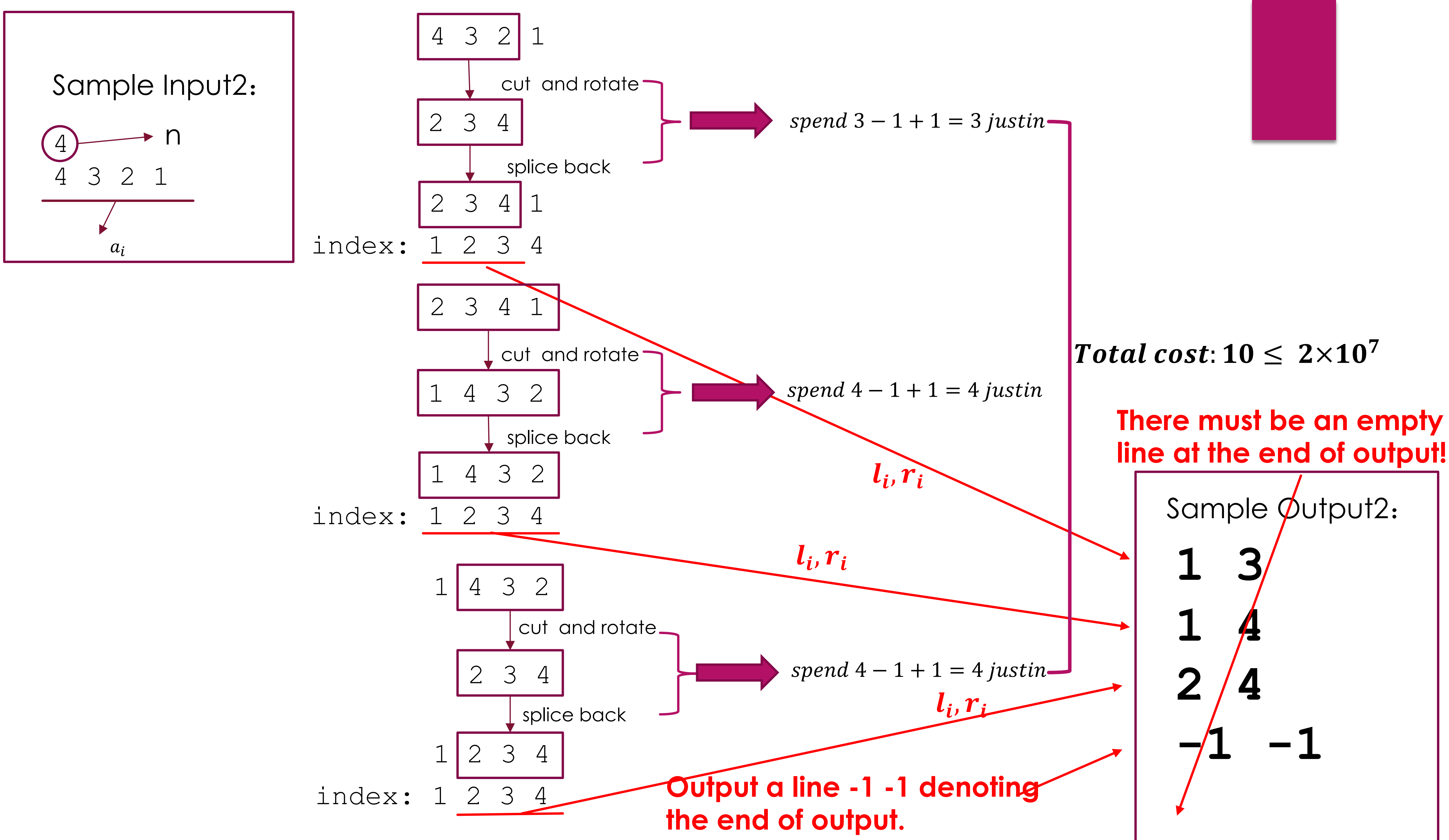
Sample Output1:

```
2 3
-1 -1

```

Output a line -1 -1 denoting the end of output.

There must be an empty line at the end of output!



Sample Input2:

```
4
4 3 2 1
```

$spend\ 3-1+1=3\ justin$

$spend\ 4-1+1=4\ justin$

$spend\ 4-1+1=4\ justin$

$\boldsymbol{Total\ cost}: \mathbf{10} \leq\ \mathbf{2{\times}10^7}$

There must be an empty line at the end of output!

Sample Output2:

```
1 3
1 4
2 4
-1 -1
```

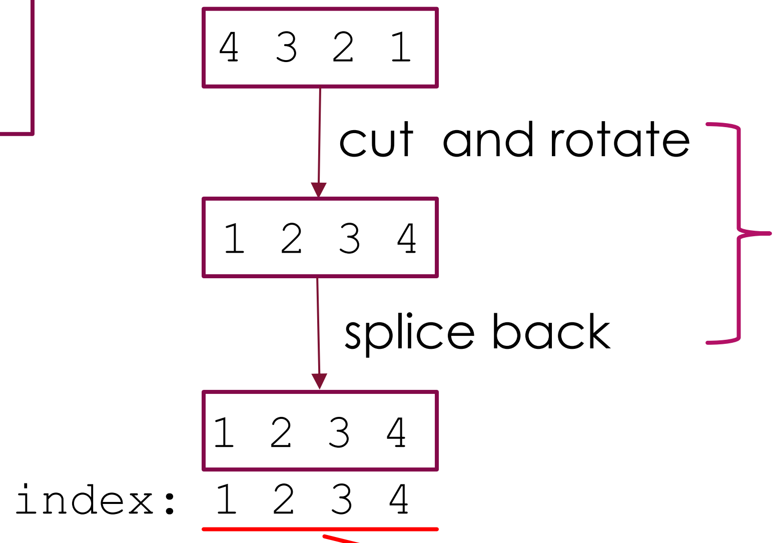
Output a line -1 -1 denoting the end of output.

Sample Input2:

```
4
4 3 2 1
```

a_i

If there are multiple solutions, you can print any of them.



```
4 3 2 1
```

cut and rotate

```
1 2 3 4
```

splice back

```
       1 2 3 4
index: 1 2 3 4
```

$spend\ 4-1+1=4\ justin$

$\boldsymbol{Total\ cost: 4 \leq\ 2 \times 10^7}$

$\boldsymbol{l_i, r_i}$

Sample Output2:

```
1 4
-1 -1

```

Output a line -1 -1 denoting the end of output.

There must be an empty line at the end of output!

index:	1	2	3	4
element:	1	3	2	4

first sort the element:

index:	1	3	2	4
element:	1	2	3	4

rank:	1	3	2	4

Assume all a_i have the same value:

1	1	1	1	1	1

Assume all a_i have 2 different value:

1	2	1	2	1	2

Assume all a_i have 4 different value:

3	2	4	1	3	2

Assume all a_i have different value:

6	4	2	1	5	3

Assume all a_i have the same value:

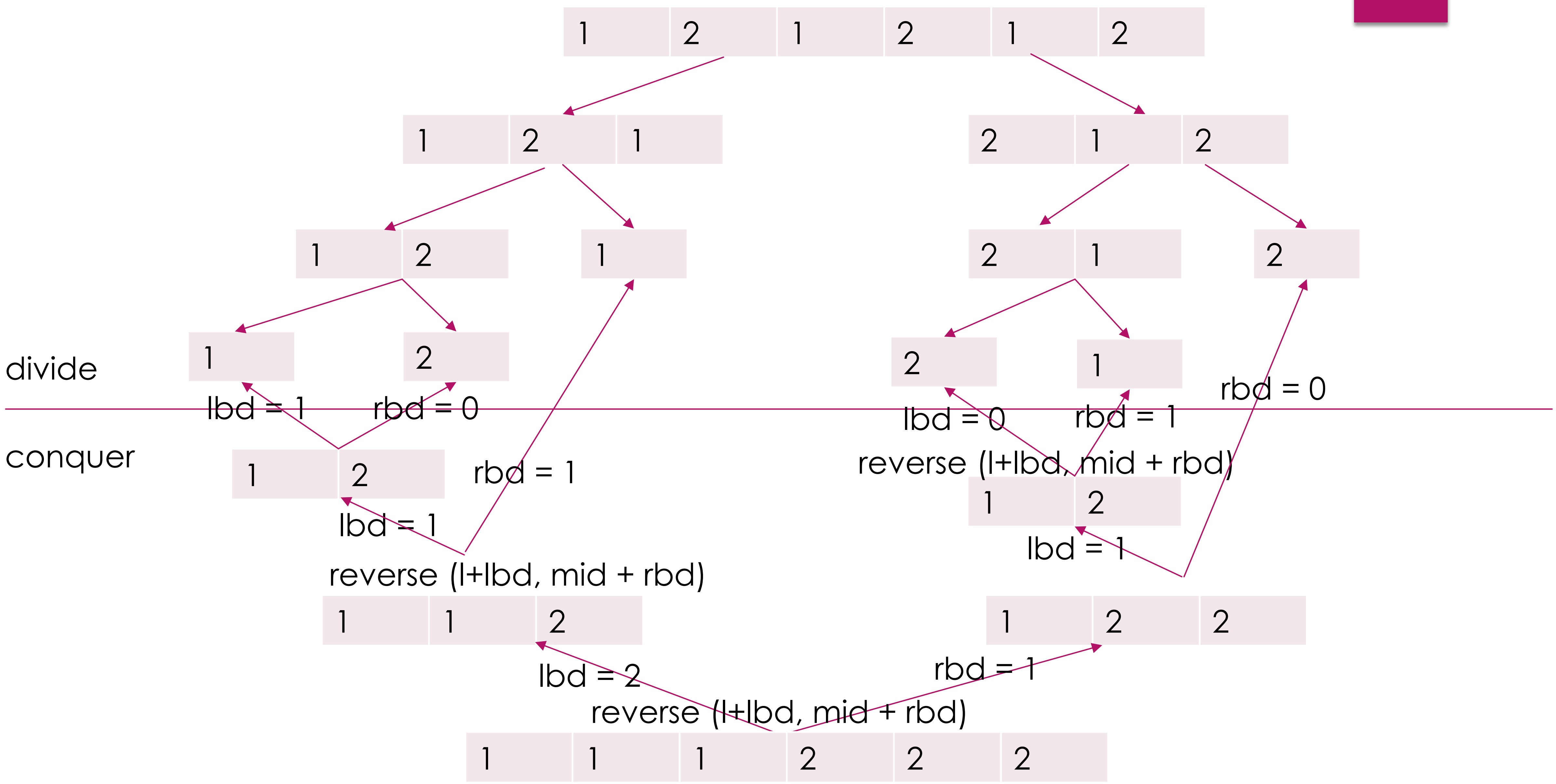
1	1	1	1	1	1

No need reverse operations

Assume all a_i have 2 different value:

1	2	1	2	1	2

try merge sort
record the boundary between 1 and 2



1 2 1 2 1 2

1 2 1

2 1 2

1 2

1

2 1

2

divide

1

2

2

1

lbd = 1

rbd = 0

lbd = 0

rbd = 1

rbd = 0

conquer

1 2

rbd = 1

reverse (l+lbd, mid + rbd)

1 2

lbd = 1

lbd = 1

reverse (l+lbd, mid + rbd)

1 1 2

1 2 2

lbd = 2

rbd = 1

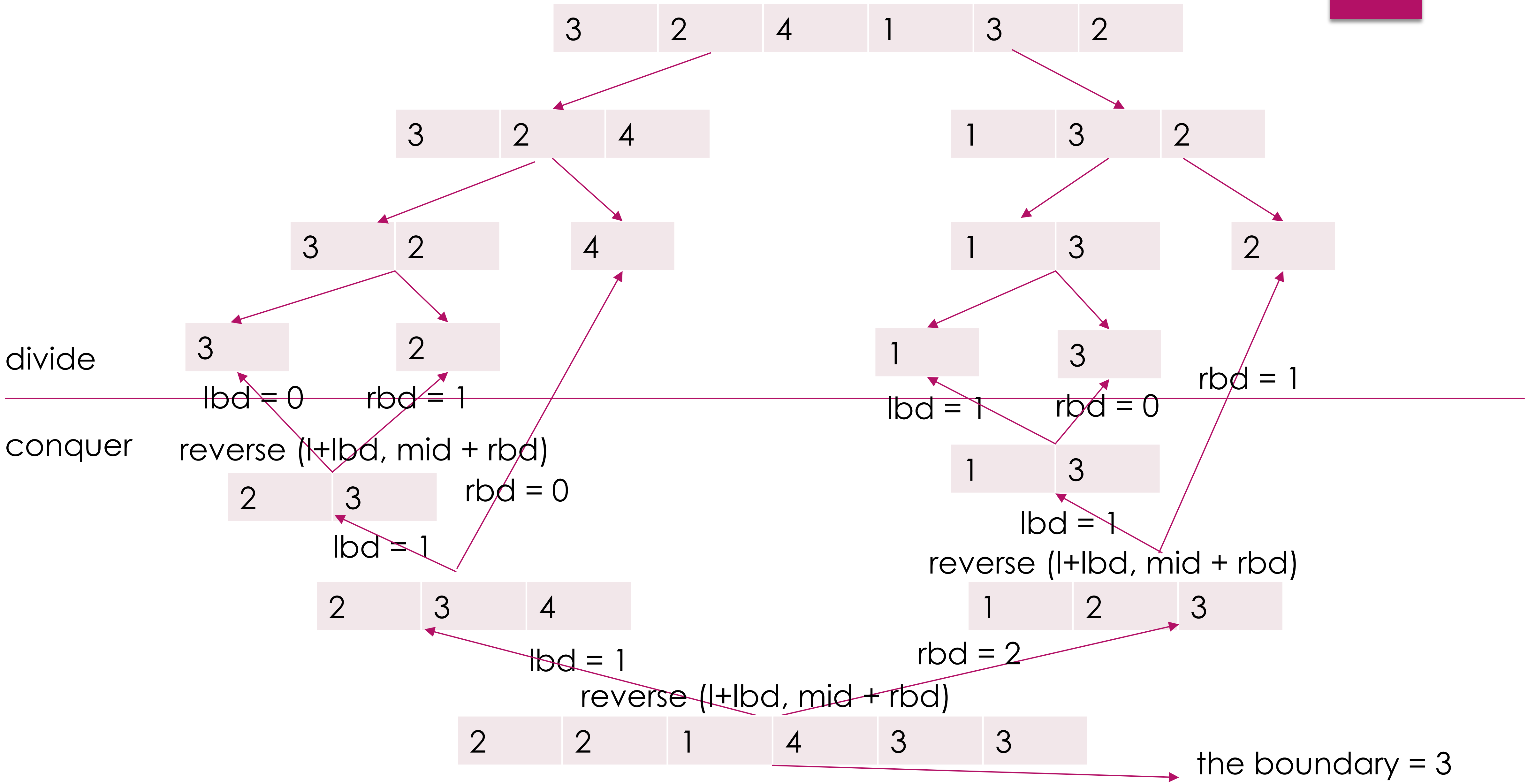
reverse (l+lbd, mid + rbd)

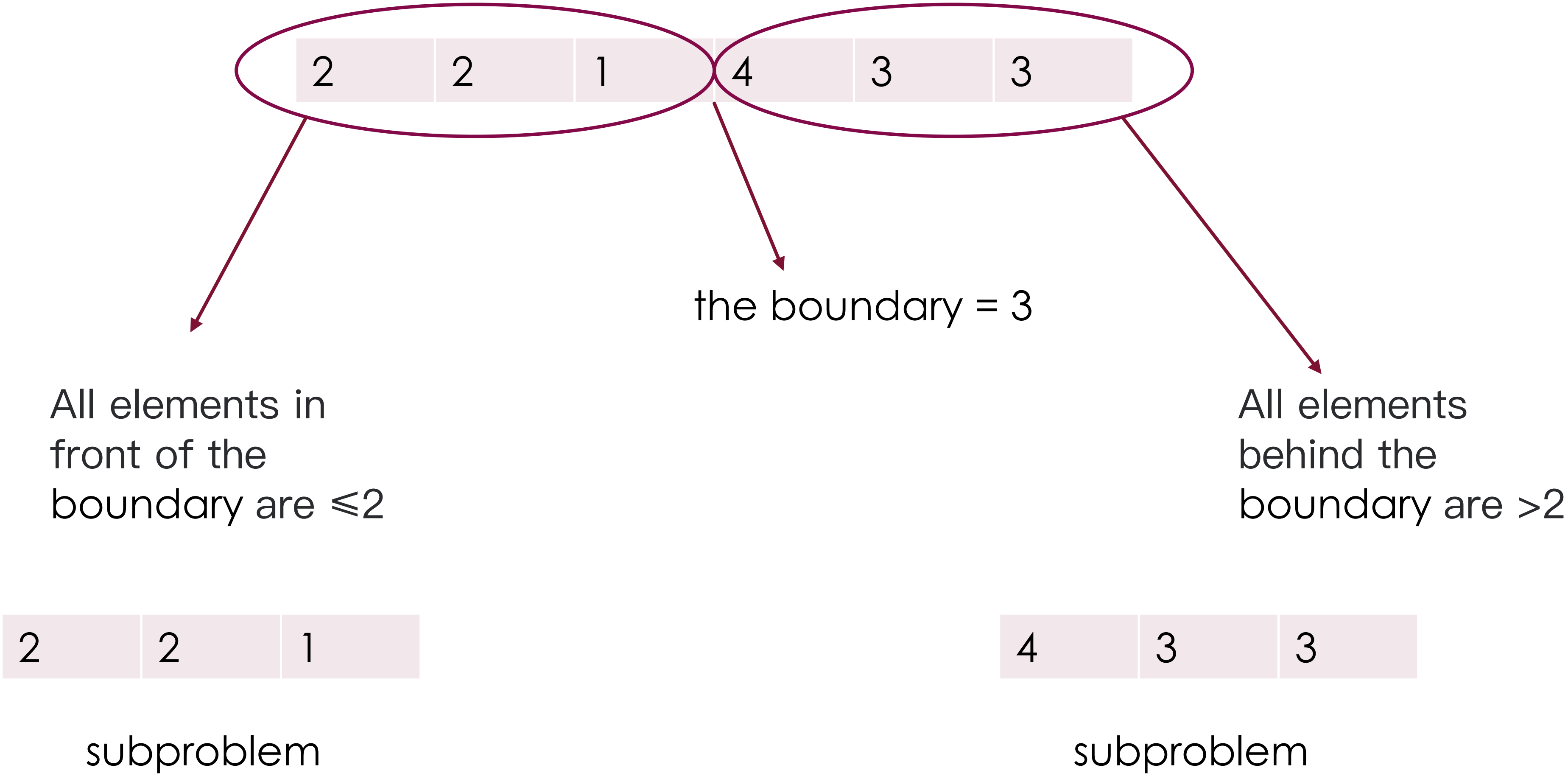
1 1 1 2 2 2

Assume all a_i have 4 different value:

3	2	4	1	3	2

similarly,
first, record the boundary <=2 and >2





2 2 1 4 3 3

the boundary = 3

All elements in front of the boundary are ⩽2

All elements behind the boundary are >2

2 2 1

subproblem

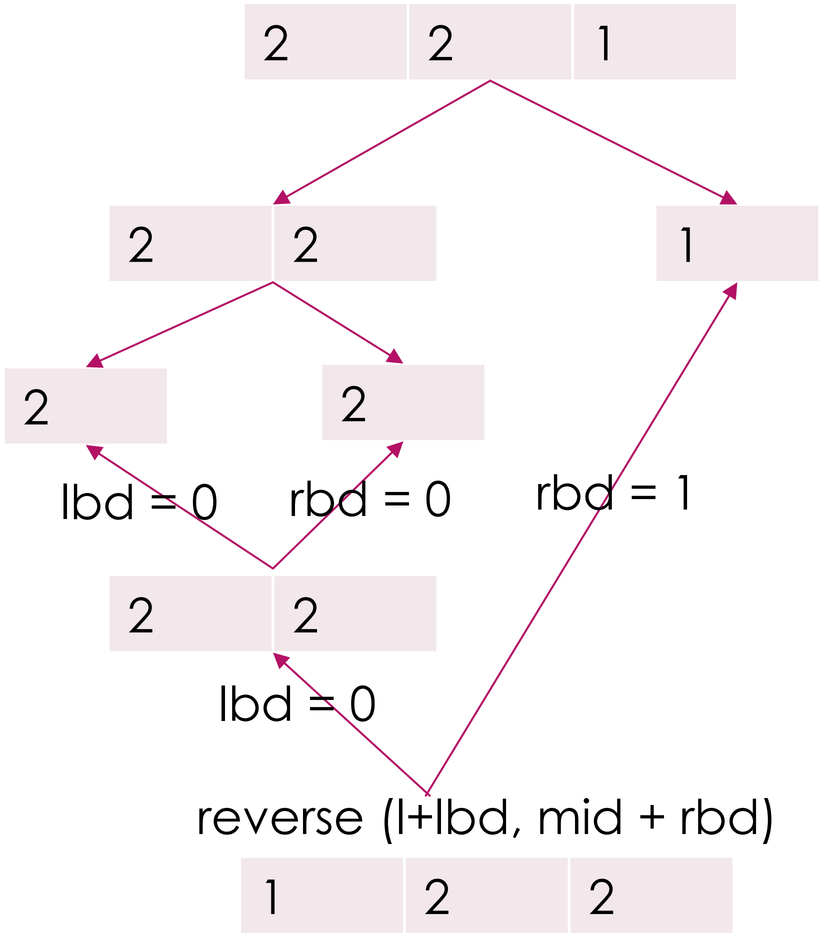
4 3 3

subproblem

2	2	1

subproblem

For this subproblem,
record the boundary <=1 and >1



2 2 1

2 2

1

2

2

lbd = 0

rbd = 0

rbd = 1

2 2

lbd = 0

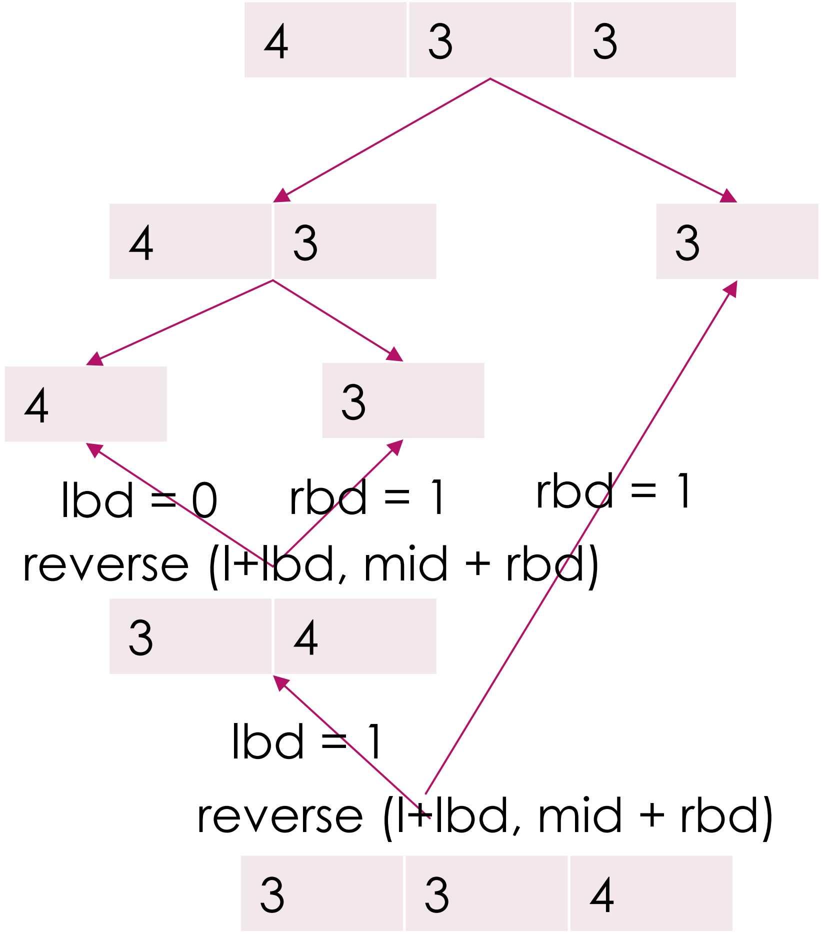
reverse (l+lbd, mid + rbd)

1 2 2

4	3	3

subproblem

For this subproblem,
record the boundary <=3 and >3



4 3 3

4 3

3

4

3

lbd = 0

rbd = 1

rbd = 1

reverse (l+lbd, mid + rbd)

3 4

lbd = 1

reverse (l+lbd, mid + rbd)

3 3 4

6	4	2	1	5	3

How to solve?

1	1	4	3	2	1	1	1	1	1