$K=3$

n points

(x_1, y_1)

(x_2, y_2)

(x_3, y_3)

$(0,0)$

origin

x

y

$O(n \log n + K \log n)$

$\left(n + n \log n + K \log n\right)$

$O(n \log n + K \log K)$

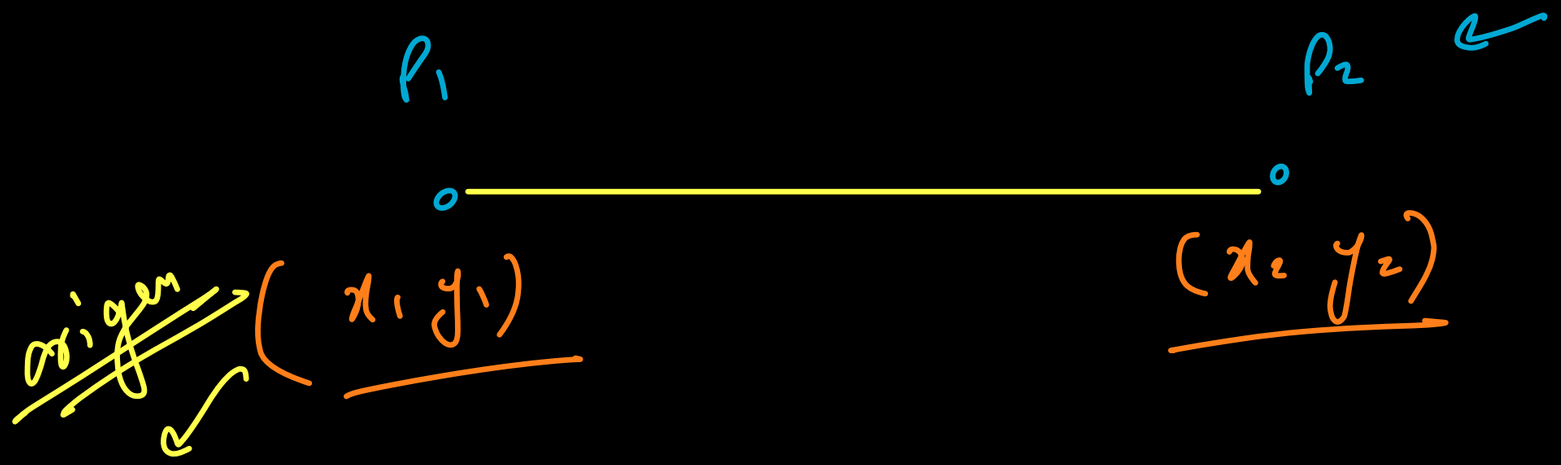
$\sqrt{1^2+3^2} \rightarrow \sqrt{10}$

$\sqrt{(-2)^2+2^2} \rightarrow \sqrt{8}$

$[(1,3) \quad (-2,2)] \longrightarrow [\sqrt{10}, \sqrt{8}]$

n

K-smallest

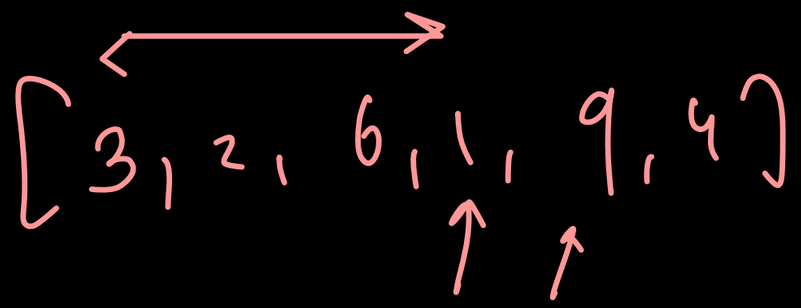


→ (manhattan distance)

→ (euclidean dist)

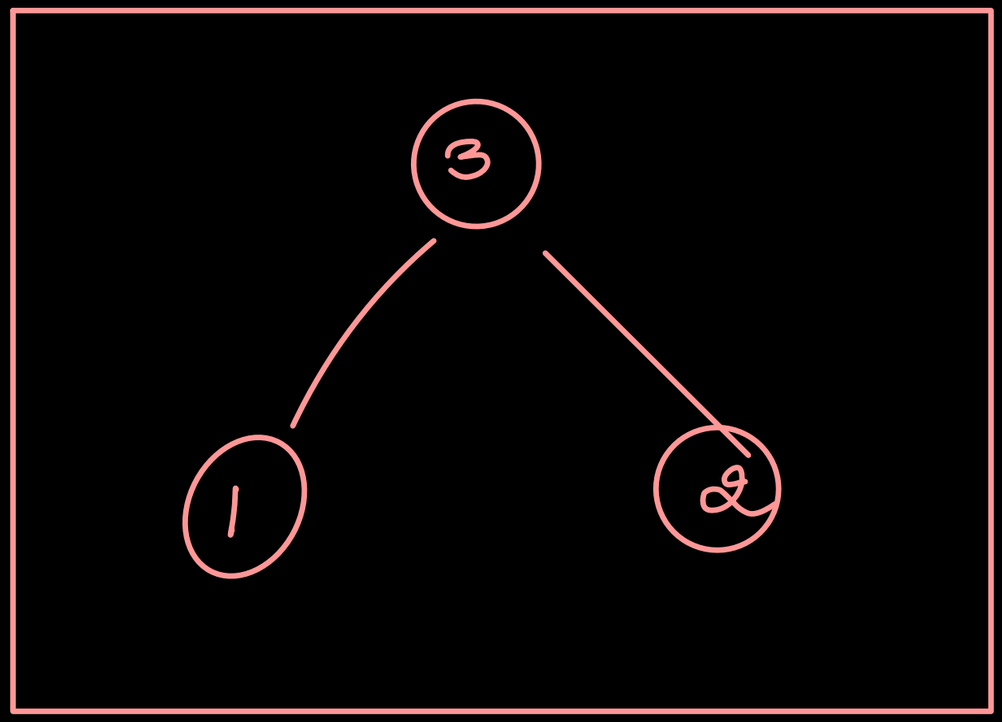
$$\sqrt{(x_2 - x_1)^2 + (y_2 - y_1)^2}$$

↳ $\sqrt{(x_2 - 0)^2 + (y_2 - 0)^2} \Rightarrow \sqrt{x_2^2 + y_2^2}$ //



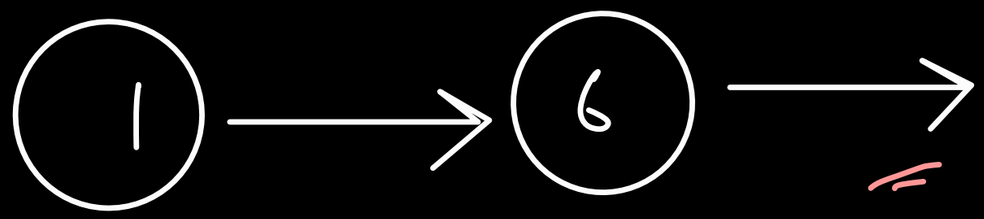
k=3

max heap => 3

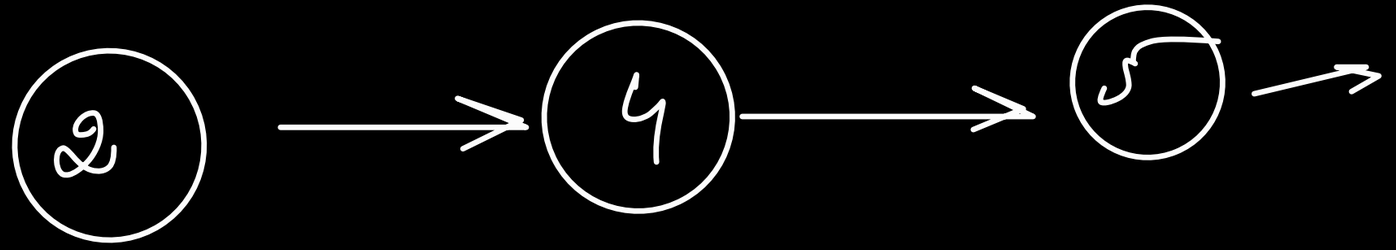


ll 0

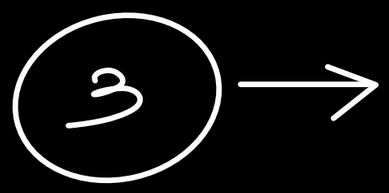
ll 1



ll 2



ll 3



Heap of size K

3 → 4 → 9 → 10 → 1 → 6 → 2 → 4 → 5 → 3

Combined list

(nk(log(nk) + ~~nk~~

mergesort

Total nodes ⇒ nk

O((nk) log (nk))

Space → O(nk)

Can we improve

ll0 → 3 → 4 → 9 → 10 →

ll1 → 6 →

ll2 → 4 → 5 →

ll3 → 3 →

t = 3

(2, 2)

K

(3, 0)

(6, 1)

(3, 3)

Result → 123 → 1 → 2

head

dummy

temp

$O(nk \log k)$

[1, 2, 3, 5] → $O(n^2)$

1/5 1/3 1/2 1

2/5 2/3 1

3/5 1

$\log(n^2) \simeq \log n$

$2\log n + ((c-1)\log n$

$$[\overset{0}{1}, \overset{1}{2}, \overset{2}{3}, \overset{3}{5}]$$

→ 1/5 2/5 3/5 5/5 → sorted

→ 1/3 2/3 3/3 → sorted

→ 1/2 2/2 → sorted

→ 1/1

(0, 2, 1/3)

K=3

K=1

→

→

min heap

(1, 3, 2/5)	(0, 1, 1/2)
(1, 2, 2/3)	(0, 0, 1)

→ 1

2/5 → 0.4

1/2 → 0.5

1/3 → 0.3

1 → 1

$$(n \log n + (k-1) \log n)$$

$$O((n+k) \log n)$$