

$a_0 \ a_1 \dots a_{n-1}$, \underline{x}
 $a_i + a_j = x ?$ | $x - a_i$

$i \rightarrow 0 \text{ to } n$ $\theta(n^2)$
 $j \rightarrow i \text{ to } n$
 if $(a_i + a_j == x)$
 return true;
 return false;

$i \rightarrow 0 \text{ to } n$
 $x - a_i$
 $i \rightarrow 0 \text{ to } n$
 a_i

$\rightarrow \underline{\underline{\theta(n)}}$

$\checkmark \theta(n) \text{ space}$

Sort(A) $\rightarrow \theta(n \log n)$

$a_0 \leq a_1 \leq a_2 \leq \dots \leq a_{n-1}$

$i \rightarrow 0$ to n .

BS($x - a_i$) | $\theta(n \log n)$

$x - a_i = a_j$

$x = a_i + a_j$

$\theta(n)$

$l = 0; r = n-1$

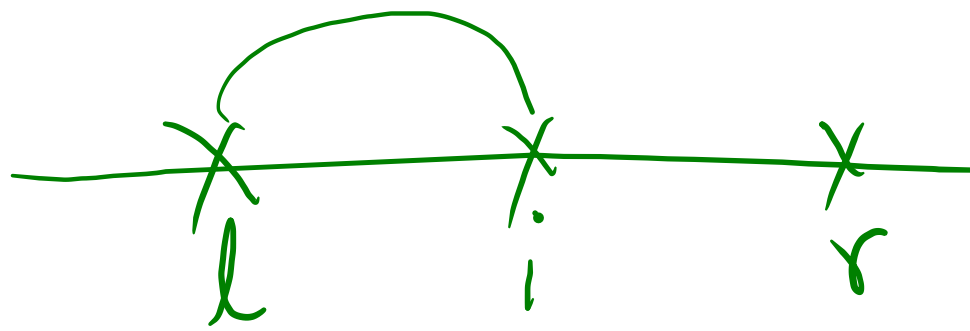
while ($l \leq r$)

if ($a_l + a_r = x$) return true;

else if ($a_l + a_r < x$) $l++$;

else $r--$;

$\theta(n)$



$$a_l + a_r > x$$

$$i \geq l$$

$$a_r + a_i \geq a_l + a_r > x$$

$$\underline{a_r + a_i > x}$$

$$i \leq r$$

$$a_l + a_i \leq a_r + a_l < x$$

$$\Rightarrow \underline{a_l + a_i < x}$$

$$\underline{a_l + a_r < x}$$

$$i \leq r$$

$$a_i \leq a_r$$

$$-a_i \geq -a_r$$

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$a_0 - \dots - a_{n-1}$

$$a_i - a_j = x \quad \text{H.W}$$

$> x$



$$a_r - a_l > x$$

$$a_r - a_l < x$$

$$a_r - a_l$$

$$l = 0 \quad r = n - 1$$

while ($l \leq r$)

if ($a_i - a_j == x$)
return true.

else if ($a_l - a_r < x$)
l++

else r--;

$i, n=10^5$
 x x_j

hash[ai]

hashing. ~~app~~

$a_i + a_j$ hashing.

Time $\theta(n^2) / \theta(n^2) \rightarrow$ ~~bad~~
 Space $\theta(n^2) / \theta(n)$

$a_i + a_j = a_k$? i, j, k
 $a_0 - \dots - a_{n-1} : x = a_k$

a_k

$\theta(n^2)$

open.

Sort(A) $\rightarrow \theta(n \log n)$

$k = 0$ to n
 $x = a_k$
 $l = 0; r = n-1$
 while ($l \leq r$)
 if ($a_l + a_r = a_k$)

$$q_i - q_j = q_k$$

$$2q_i - 3q_j = 5q_k$$

$$\Rightarrow q_i = q_j + q_k$$

$$q_i = \frac{3}{2}q_j + \frac{5}{2}q_k$$

$$a_i + a_j = \frac{a_k + a_m}{X} \quad \begin{array}{l} i \neq k, m \\ j \neq k, m \end{array}$$

Hashing.

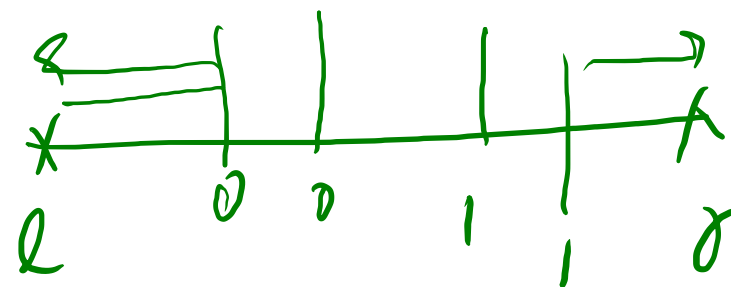
T	$\Theta(n^2)$	$\Theta(n^3)$
S	$\Theta(n^2)$	$\Theta(n)$
		$\frac{\Theta(n)}{\Theta(1)}$

$$\begin{array}{l|l} \Theta(n^2) & \begin{array}{l} k \rightarrow 0 \text{ to } n \\ m \rightarrow 0 \text{ to } n \end{array} \\ \hline & X = a_k + a_m \end{array}$$

$\Theta(n)$ [

0's	1's
<hr/>	
≠ 0's	1's

$\Theta(n)$



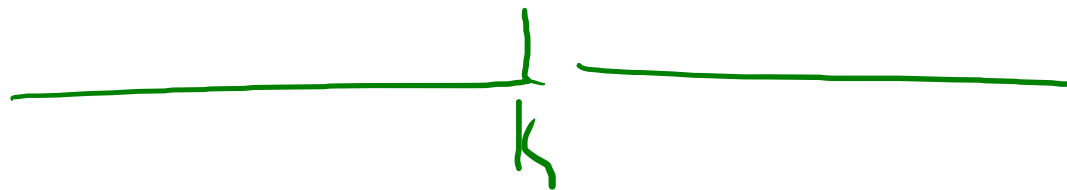
$k = l - 1$.

① $k = -1$

$k = 0$

$b = 0$

$b = 1$



$O's$

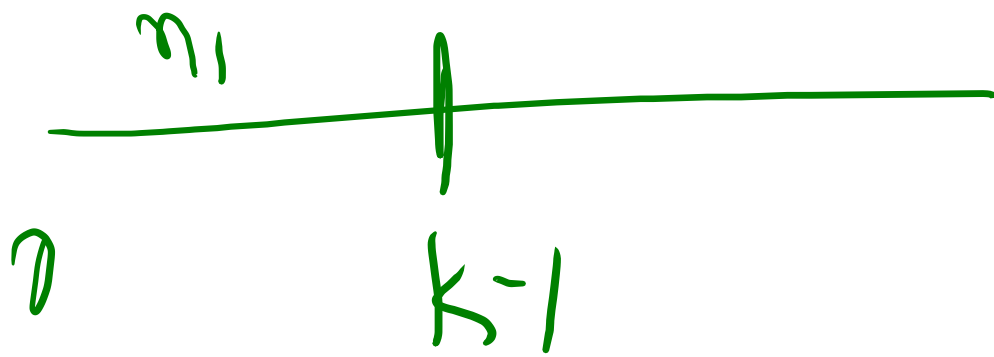


$O(n)$

$k = -1$

$i \rightarrow 0$ to n

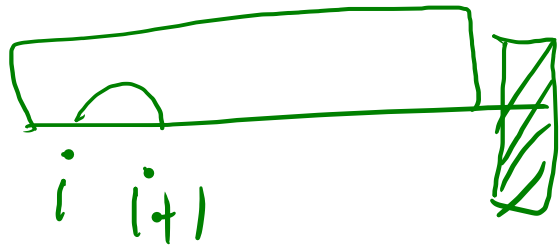
$y(a[i] == 1) \quad k++;$



$$\begin{aligned} & \# 0's \text{ in left} \\ & = k - n_1 \end{aligned}$$

$k \rightarrow \# 1's \text{ in string.}$

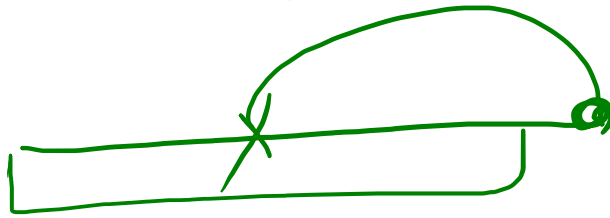
BS



$$T(n) = T(n-1) + \theta(n) \\ = \theta(n^2)$$

Swaps $\theta(n^2)$
w.c.

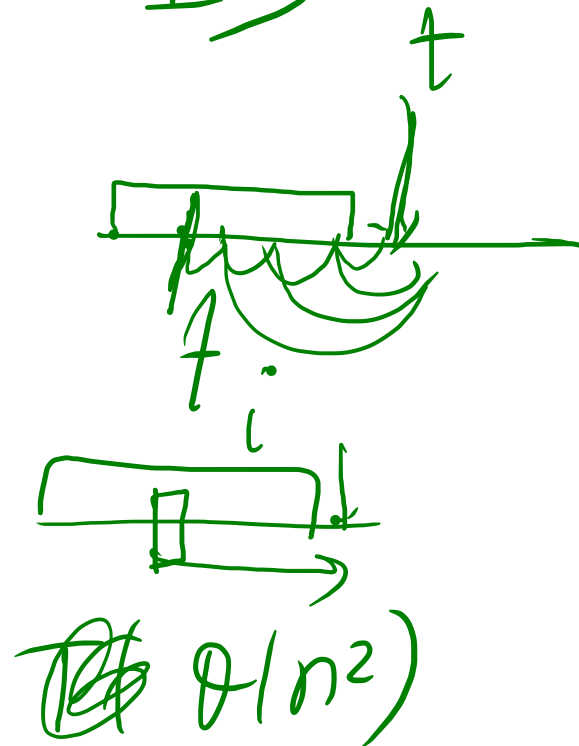
SS



$$T(n) = T(n-1) + \theta(n) \\ = \theta(n^2)$$

Swaps. $\theta(n)$

IS



~~$\theta(n^2)$~~

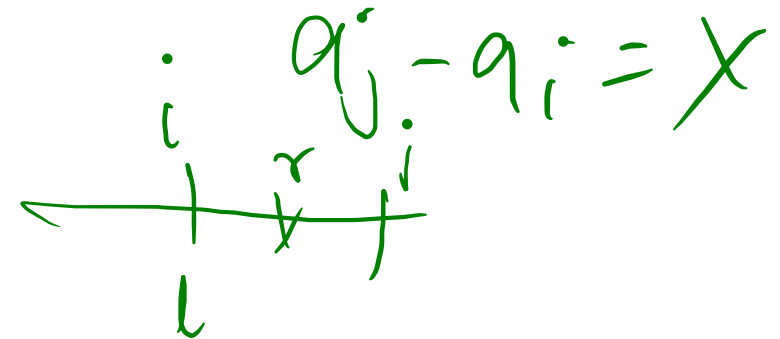
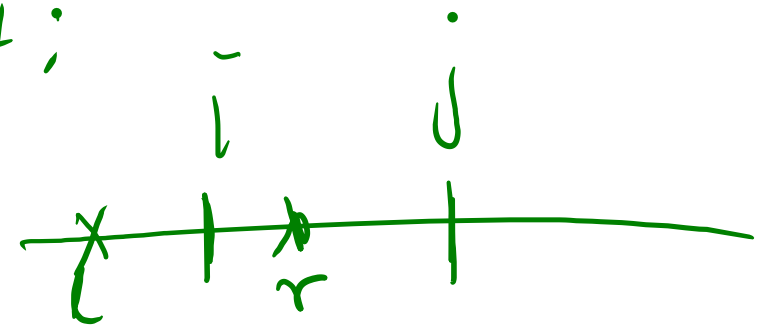
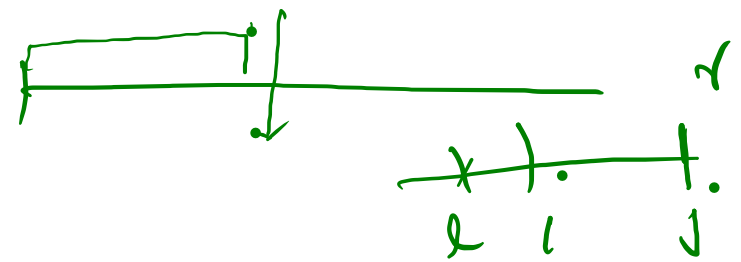
$l = r = 0$

while ($r < \text{gn}$)

if ($\frac{a_r - a_l}{r - l} < X$) $r++$;
 else $l++$;

return false;

if ($a_r - a_l == X$) return true;



$\Theta(n)$

