

Input array: [101, 102, 103, ..., 10n] (represented as a vertical list with a red arrow pointing to the first element)

101	✓	1	
102	x	2	
103	x	4	
⋮	⋮	⋮	⋮

Freq. Array $A \rightarrow [2, 3, 5, 3, 3, 1, 5, 3]$

Freq. Array $\rightarrow [0, 1, 1, 4, 0, 2]$

$\boxed{0 \ 1 \ 2 \ 3 \ 4 \ 5}$

Key
 Value

→ key → unique
 i] → value

$0 \leq A[i] \leq 10^9$

→ Is freq. array possible?

If we are only allowed size \boxed{N} freq. array.
 $\uparrow \approx 10^6$
 $[10^8, 287\ 365\ 42, 1, 10, \dots]$

$h(A[i]) = \lfloor A[i] \% M \rfloor$ <p style="text-align: center;">$0 \leq \quad < M$</p> <p><u>Hash Function</u></p> <p>element that was supposed to be key.</p>	$M = 17 \quad A[10, 20, 30, 27]$ <p>$h(10) = 10 \% 17 = 10$</p> <p>$h(20) = 20 \% 17 = 3$</p> <p>$h(30) = 30 \% 17 = 13$</p> <p>$h(27) = 27 \% 17 = 10$</p>
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$\rho \rho \rho$  $0 0 0 0$

A hand-drawn diagram of a stack frame. It consists of two blue brackets on the left and one yellow bracket on the right. The top blue bracket contains the word "random" underlined in blue ink. A blue arrow points from the bottom of the top blue bracket down towards the bottom yellow bracket.

$$h(x) = x \% M$$

Chaining ✓ $M = 5$

(Actual Key, Value)

$A \Rightarrow [2, 4, 5]$

Key	Value
0	(5, 3) \rightarrow (10, 1) \rightarrow (20, 1) \rightarrow (40, 1) ...

$2 \% . 5 = 2$ 10

$1 \% 5 = 1$
 $5 \% 5 = \underline{0}$
 $7 \% 5 = 2$
 $20 \% 5 = \underline{0}$
 $4 \% 5 = 1$

Worst TC for search/insertion
 $= \underline{O(N)}$

Freq of 7?
 $7 \% 5 = \underline{\underline{2}}$

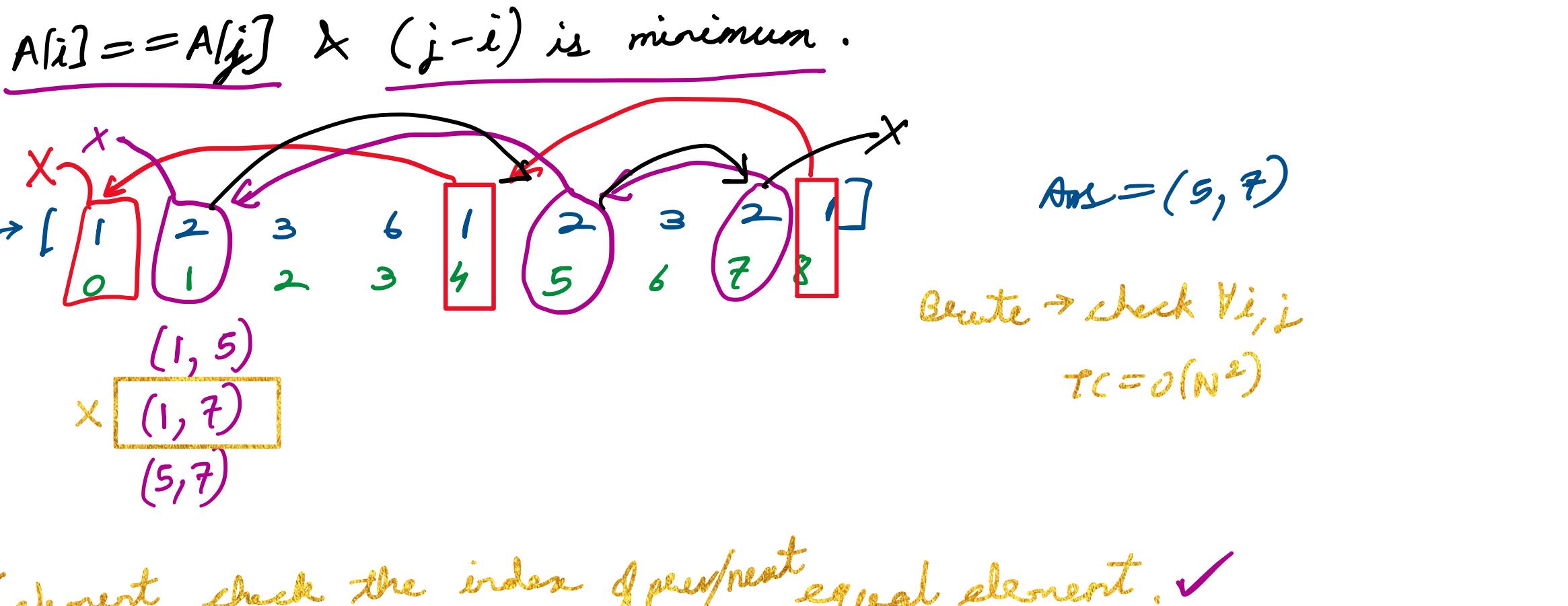
\Rightarrow In Java8 if chain size ≥ 4 it creates a BST.

Binary Search Tree

$TC \approx O(\log(N))$

→ Search / Insert
= $O(N)$ / Hash Map ✓ Unordered

	<u>Map</u>
Java	C++
HashMap	unordered map



$F[i] \rightarrow$ index of prev. equal value $F[2] = 1$
 current at idx 5

Key Value imp:
 $A[i]$ index
 $1 \rightarrow 0 \times 8$
 $2 \rightarrow + 5 \times 7$
 $3 \rightarrow \times 6$
 $6 \rightarrow 3$
 $SC = O(N)$
 $TC = O(N)$

Ans = $(0, 4) \times$ $4-0=4$
 $(1, 5) \times$ $5-1=4$
 $(2, 6) \times$ $6-2=4$
 $(5, 7) \checkmark$ $7-5=2$
 $(4, 8) \times$ $8-4=4$

$\Theta \rightarrow$ Given an integer array. Find a subarray with sum = 0 with largest length.

$|A| \approx 10^5 \quad \checkmark$

$A[i] \leq 10^9 \quad \checkmark$

question

$$\rightarrow + (A[0] + A[1] + \dots + A[i-1])$$

$$\rightarrow - (A[0] + A[1] + \dots + A[i-1])$$

$$P[i-1]$$

$$(i, j)$$

$$A[0] + A[1] + A[2] + \dots + A[j]$$

$$P[j] = P[i-1]$$

$$(j-i) \text{ moe}$$

$$P[j] - P[i-1] = 0 \Rightarrow$$

$$A[0] + A[1] + A[2] + \dots + A[i-1]$$

Velenent check first occurrence of that element ✓

Key Value

$A[i]$	First occurrence
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$\{ A[i] \}$
 $(i-1)$ $0 \rightarrow -1$

$0 \rightarrow 0$
 $i-1 \rightarrow 0$ $i-j$

$-1 \rightarrow 2 \leftarrow \begin{matrix} p[i] \\ i-1 \end{matrix} = p[3]$

$5 \rightarrow 4 \leftarrow \begin{matrix} p[i] \\ i-1 \end{matrix} = p[5]$

$p[4] == p[5]$

$A[1] \quad -3 \quad 2 \quad 3 \quad 4 \quad 5 \quad 6$

$\rightarrow 1 \quad \rightarrow 0 \quad 1 \quad 2 \quad 3 \quad 4 \quad 5$

$P = 0 + 1 = 1 + (-2) = -1 + 2 = 1 + 4 = 5 + 0 = 5$

$P = P + A[i]$

$Ans \rightarrow (2, 3) X$
 $(5, 5) X$
 $(2, 6) \checkmark (Ans)$
 $p[1] == p[6]$

$T.C = O(N)$

Sort \downarrow $T = O(n \log n)$
 $\{3 \ 4 \ 5 \ 6 \ 10 \ 11 \ 20 \ 100 \ 101\}$
 \Rightarrow if ($A[i] == A[i-1] + 1$) chainlength++
 else if ans = max(ans, chain length);
 chain length = 1;
 }
 i.e. . . . t is even should we start a chain from x ? x

If $(x-1)$ is present in array then do -

\Rightarrow start a chain from x if $(x-1)$ is not present - (i)

insert

present in array ✓

$O(\log(N)) \rightarrow$ sort ✓

$O(1) \rightarrow$ hash set

insert $\forall i A[i]$ in set & check in $O(1)$

SC = $O(N)$ ✓

TC = $O(N)$

set

100
4
3
6
10, 20, 11, 5, 10

3 length

check

$TC = O(2^N)$
 $= O(N)$

1 length chain (k-1) elements need $\rightarrow (k-2)$

$i \rightarrow$ k checks
 $(k-2)$ valid checks \Rightarrow present
1 check ✓

\rightarrow An \rightarrow length
 \rightarrow 100, 101 X
 \rightarrow 3, 4, 5, 6 ✓

$+ K$
 $= 2K-2$ searches

→ 2 not found & 3 found search
↓
TC when we are at these locations = 0