

45.

Of course, we can!



• ATENÇÃO: Quando se redimensiona a hash, todos os índices tem de ser recalculados! (U = USED)

$$h(1) = 1 \cdot 1 = 0$$

insert

U
1

 $\lambda = \frac{1}{1} = 1 \rightarrow 100\% \rightarrow \text{redimensionar:}$
 $2 \times 1 + 1 = 3$

insert

U	U
3	1

 $h(1) = 1 \cdot 3 = 1$
 $h(3) = 3 \cdot 3 = 0$
 $\lambda = \frac{2}{3} = 0,6 \rightarrow 66\% \geq 50\% \rightarrow \text{Redimensionar}$
 $2 \times 3 + 1 = 7$

insert

U	U	U	U
1	3	5	7

 $h(1) = 1 \cdot 7 = 1$
 $h(3) = 3 \cdot 7 = 3$
 $h(5) = 5 \cdot 7 = 5$
 $\lambda = \frac{3}{7} \rightarrow 40\%$

insert

	1	8	3		5	
--	---	---	---	--	---	--

 $h(8) = 8 \cdot 7 = 1 \rightarrow \text{coloca} \rightarrow \text{colocar}$
 $\text{na posicao seguinte se estiver livre.}$
 $\lambda = \frac{4}{7} \geq 50\% \rightarrow \text{redimensionar}$
 $2 \times 7 + 1 = 15$

insert

	1		3		5			8		10				
--	---	--	---	--	---	--	--	---	--	----	--	--	--	--

 $h(8) = 8$
 $h(10) = 10 \cdot 15 = 10$
 $\lambda = \frac{5}{15} = \frac{1}{3} \approx 33\%$

insert

U	U		U	U		U	U
15	1		3	5		8	10

 $h(15) = 15 \cdot 15 = 0$
 $\lambda = \frac{6}{15} \approx 40\%$

remove

D	U		U	D		U	U
15	1		3	5		8	10

 $\lambda = \frac{4}{15} \Rightarrow 27\% < 33\%$
 $\downarrow 2 \times 15 = 30$
redim

10	1		3				8
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 redimensionar

Of course, we can!

$p.bal = \frac{h_e - h_d}{2}$
 desbalanceada se
 $|p.bal| > 1$

6. Iteração 1: Iteração 2: Iteração 3:

(50) BAL

(50) LEFT
 (20) BAL

(50) LEFT
 (20) LEFT
 (10) BAL

(20) BAL
 (10) BAL (50) BAL

Iteração 4:

(20) RIGHT
 (10) BAL (50) RIGHT
 (60) BAL

LEFT-LEFT → 1ª Rotação
 à direita

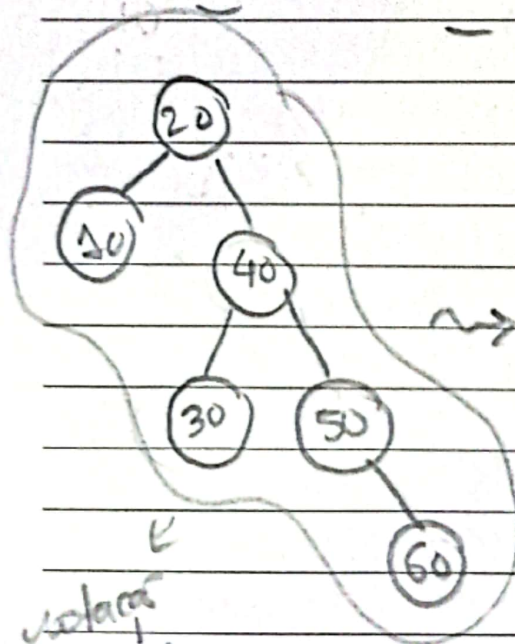
Iteração 5:

(20) RIGHT
 (10) BAL (50) BAL
 (40) BAL (60) BAL

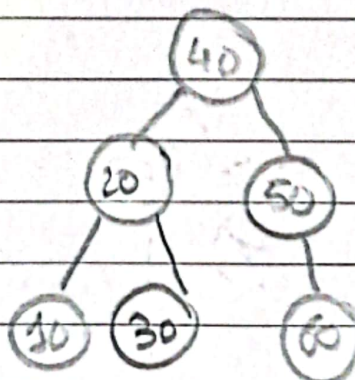
Iteração 6:

(20) LEFT
 (10) BAL (50) LEFT
 (40) LEFT (60) BAL
 (30) BAL

Temos de fazer
 rotações quando
 a diferença da
 altura é
 = 2



rotação
 esquerda



Iteração 7:

(40) RIGHT
 (20) BAL (50) RIGHT
 (10) BAL (30) BAL (60) RIGHT
 (70) BAL

Of course, we can!

17.

Iteração 1: insert 3 Iteração 2: insert 8 Iteração 3: insert 2:

(3) BAL

(3) RIGHT
(8) BAL

BAL (3) BAL
(2) (8) BAL

Iteração 4: insert 9 Iteração 5: insert 5 Iteração 6: insert 1:

BAL (3) RIGHT
(2) (8) RIGHT
(9) BAL

BAL (3) RIGHT
(2) (8) BAL
(5) (9) BAL

LEFT (3) BAL
(2) (8) BAL
BAL (1) BAL (5) (9) BAL

Iteração 7: insert 4 Iteração 8: insert 7 Iteração 9: insert 6:

LEFT (3) RIGHT
(2) (8) LEFT
BAL (1) LEFT (5) (9) BAL
(4) BAL

RIGHT (3)
LEFT (2) (8) LEFT
BAL (1) BAL (5) (9) BAL
BAL (4) (7) BAL

RIGHT (3)
LEFT (2) (8) LEFT
BAL (1) LEFT (5) (9) BAL
BAL (4) (7) LEFT
(6) BAL

rotacões
esq
(3)
(2) (5)
(1) (4) (8)
(7) (9)
(6)

BAL
(5)
(3) (8)
(2) (4) (7) (9)
(1) (6)

Se fizermos as alterações:
 $h_e = 1$ } $h_e - h_d = (-2)$
 $h_d = 3$

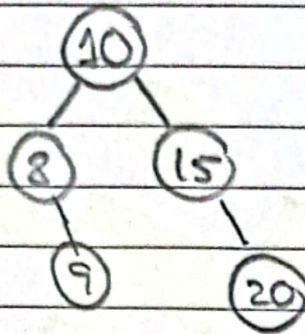
$1 - 2 = -1 < -1$

árvore desbalanceada.

rotacões para a esquerda da subárvore direita

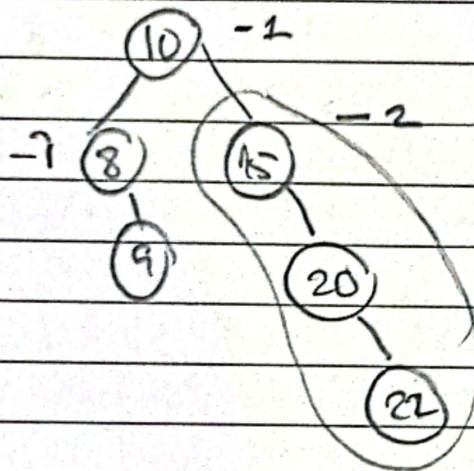
Of course, we can!

22.

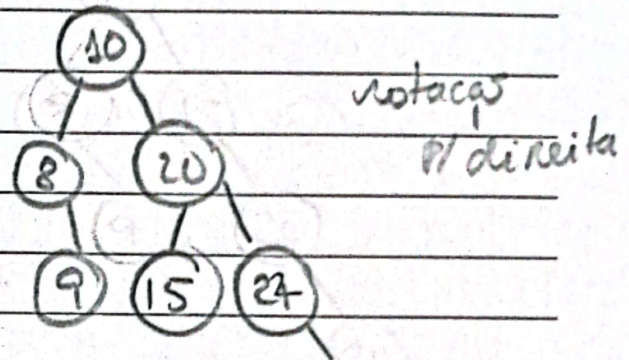


A ideia é escolher números que alterem o fator de balanço, levando a rotação de modo a puxar o 20 para a raiz da tree.

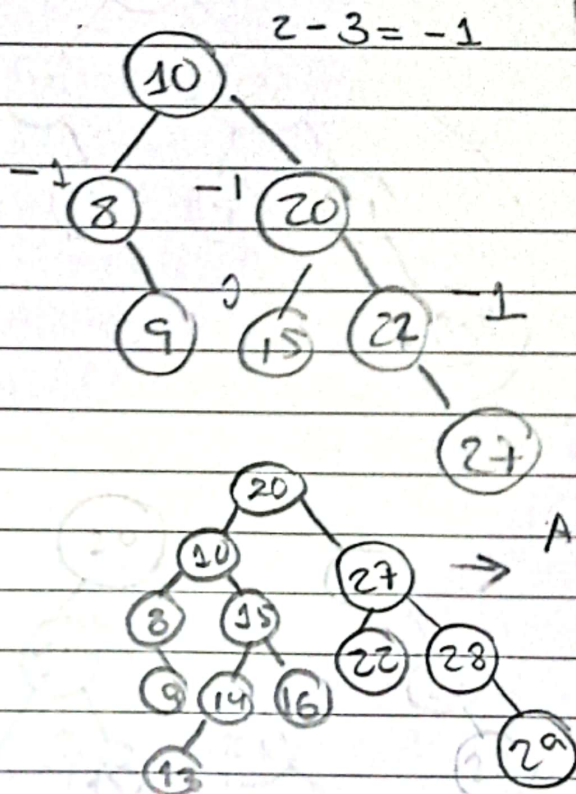
Add 22



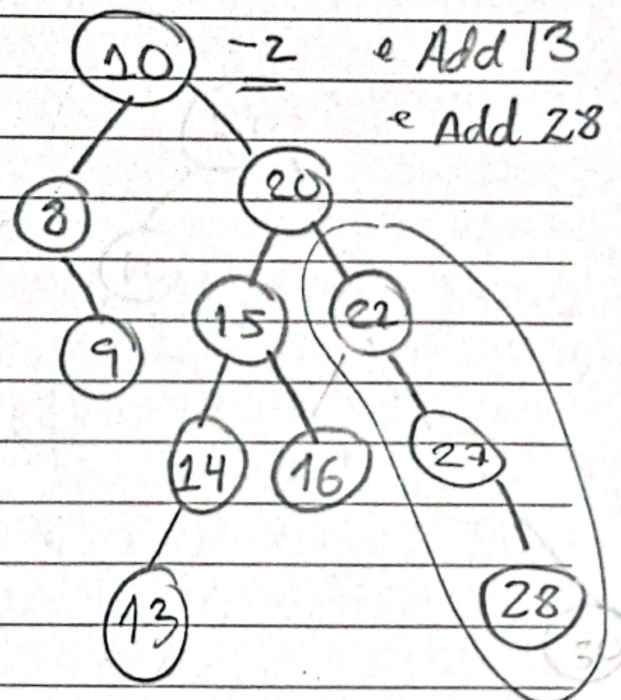
Add 25



Add 27



Add 14 e Add 16

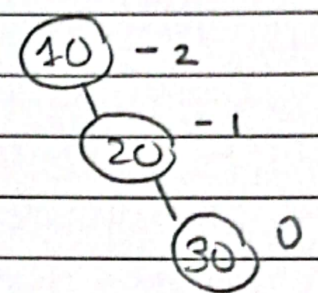
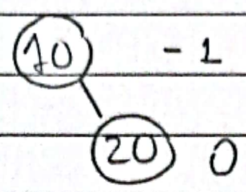
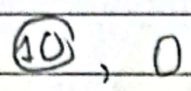


Inserções

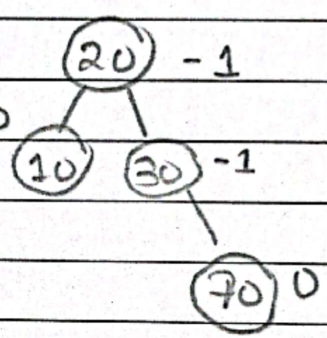
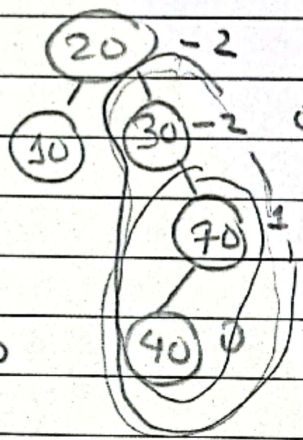
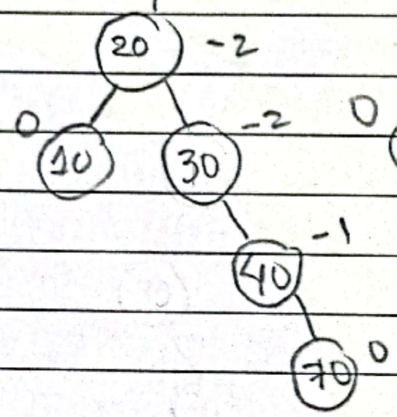
22, 25, 27, 14, 16, 13, 28, 29

Of course, we can!

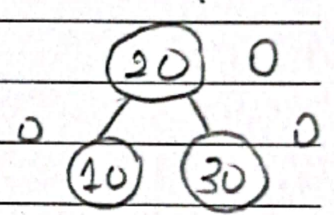
14.



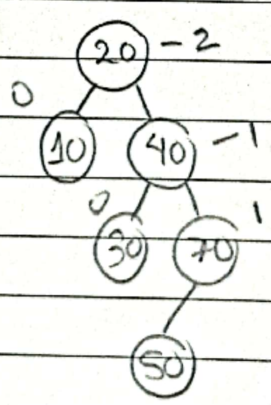
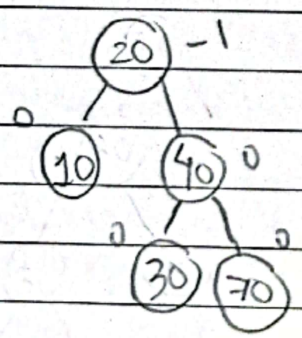
rotates



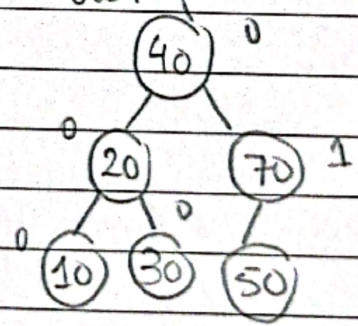
rotates



rotates



rotates



28.

0 1 2 3 4 5 6

15 ^u						
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add 15: $15 \times 7 = 1$

15 ^u			25 ^u			
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add 25: $25 \times 7 = 4$

15 ^u	9 ^u		25 ^u			
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add 9: $9 \times 7 = 2$

15 ^u	9 ^u	1 ^u	25 ^u			
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add 1: $1 \times 7 = 1$

15 ^u	9 ^u	1 ^u	25 ^u			
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Rem 9:

15 ^u	9 ^u	1 ^u	25 ^u	38 ^u		
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add 38: $38 \times 7 = 3$

15 ^u	9 ^u	1 ^u	25 ^u	38 ^u		
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rem 15: $15 \times 7 = 1$

16 ^u	15 ^u	9 ^u	1 ^u	25 ^u	38 ^u	6 ^u
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add 6: $6 \times 7 = 6$

add 10: $10 \times 7 = 3$