

**RB-insert(T , z):**

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1: y ← nil[T ]
2: x ← T
3: while x != nil[T ] do
4:     y ← x
5:     if key [z] < key [x] then
6:         x ← left[x]
7:     else
8:         x ← right[x]
9:     end if
10: end while
11: pai[z] ← y
12: if y = nil[T ] then
13:     T ← z
14: else
15:     if key [z] < key [y ] then
16:         left[y ] ← z
17:     else
18:         right[y ] ← z
19:     end if
20: end if
21: left[z] ← nil[T ]
22: right[z] ← nil[T ]
23: cor [z] ← vermelho
24: RB-insert-fixup(T , z)

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**RB-insert-fixup(T , z):**

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1: while cor [pai[z]] = vermelho do
2:     if pai[z] = left[pai[pai[z]]] then
3:         y ← right[pai[pai[z]]]
4:         if cor [y ] = vermelho then
5:             {caso1 :} cor [pai[z]] ← preto
6:             cor [y ] ← preto
7:             cor [pai[pai[z]]] ← vermelho
8:             z ← pai[pai[z]]
9:         else
10:            if z = right[pai[z]] then
11:                {caso2 :} z ← pai[z]
12:                left-rotate(T , z)
13:            end if
14:            {caso3 :} cor [pai[z]] ← preto
15:            cor [pai[pai[z]]] ← vermelho
16:            right-rotate(T , pai[pai[z]])
17:        end if
18:    else
19:        y ← left[pai[pai[z]]]
20:        if cor [y ] = vermelho then
21:            {caso1 :} cor [pai[z]] ← preto
22:            cor [y ] ← preto
23:            cor [pai[pai[z]]] ← vermelho
24:            z ← pai[pai[z]]
25:        else
26:            if z = left[pai[z]] then
27:                {caso2 :} z ← pai[z]
28:                right-rotate(T , z)
29:            end if
30:            {caso3 :} cor [pai[z]] ← preto
31:            cor [pai[pai[z]]] ← vermelho
32:            left-rotate(T , pai[pai[z]])
33:        end if
34:    end if
35: end while
36: cor [T ] ← preto

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**left-rotate(T , x):**

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1: y ← right[x]
2: right[x] ← left[y ]
3: if left[y ] != nil[T ] then
4:     pai[left[y ]] ← x
5: end if
6: pai[y] ← pai[x]
7: if pai[x] = nil[T ] then
8:     T ← y
9: else
10:    if x = left[pai[x]] then
11:        left[pai[x]] ← y
12:    else
13:        right[pai[x]] ← y
14:    end if
15: end if
16: left[y] ← x
17: pai[x] ← y

```

**right-rotate(T , x):**

```

1: y ← left[x]
2: left[x] ← right[y ]
3: if right[y ] != nil[T ] then
4:     pai[right[y ]] ← x
5: end if
6: pai[y] ← pai[x]
7: if pai[x] = nil[T ] then
8:     T ← y
9: else
10:    if x = right[pai[x]] then
11:        right[pai[x]] ← y
12:    else
13:        left[pai[x]] ← y
14:    end if
15: end if
16: right[y] ← x
17: pai[x] ← y

```