Rotations

B

RIGHT-ROTATE(B)

A

LEFT-ROTATE(A)

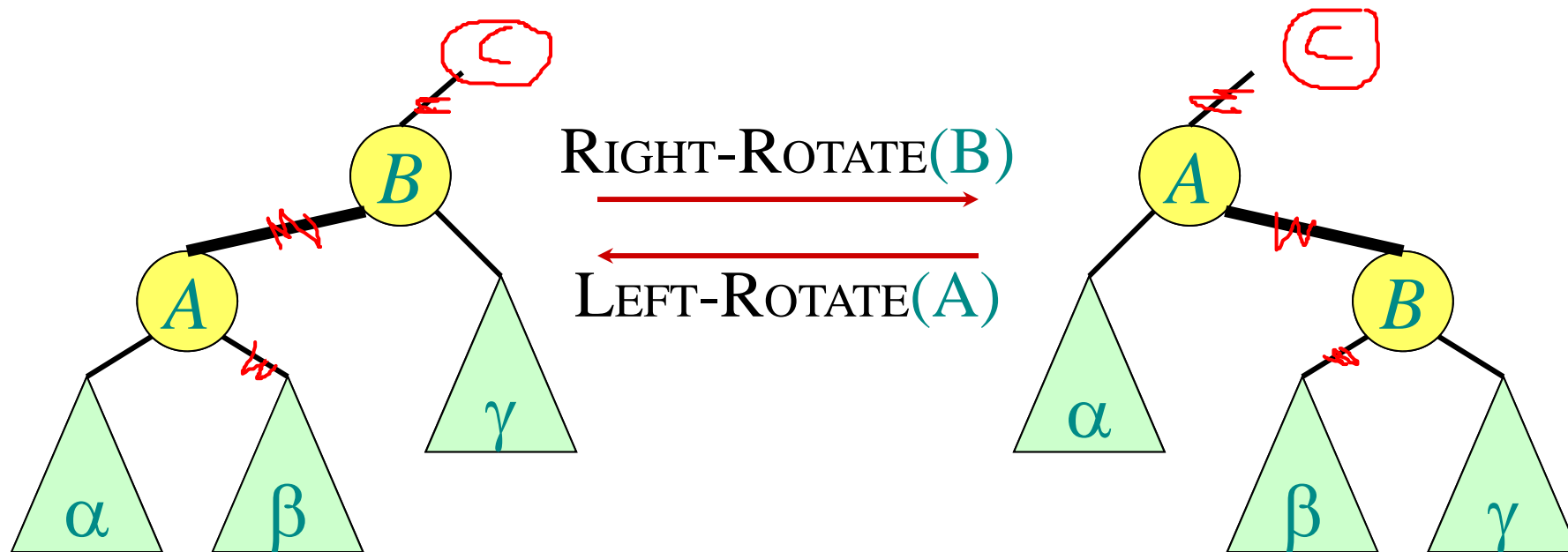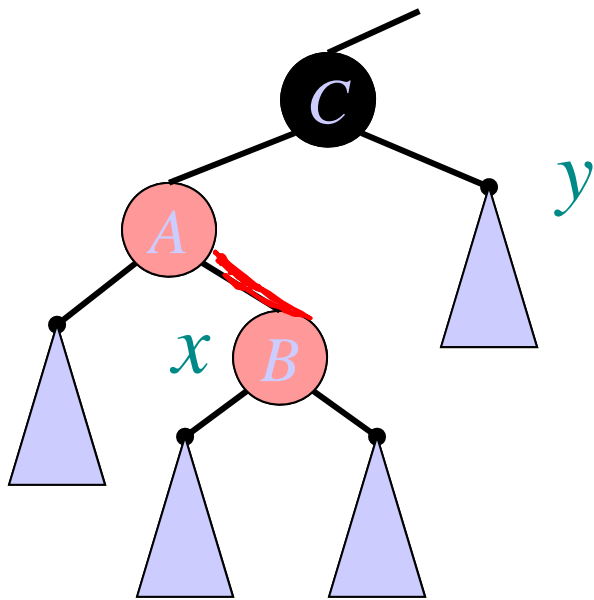A α β γ
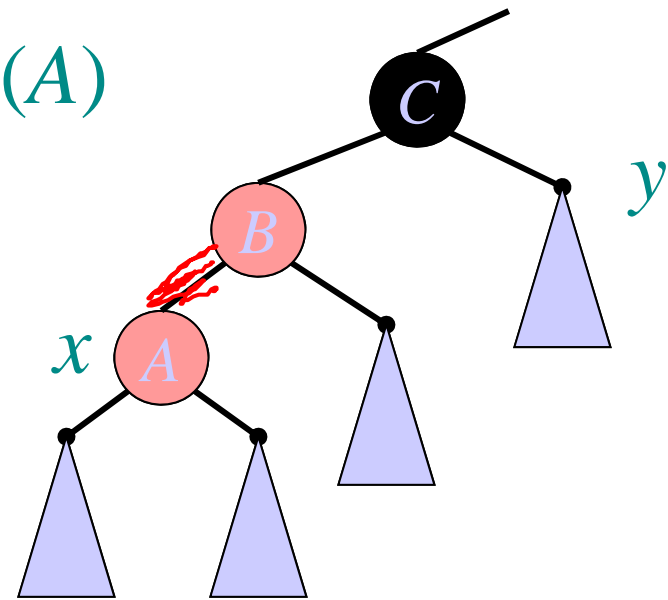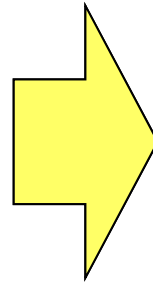
B α β γ

- Rotations maintain the inorder ordering of keys:

  $a \in \alpha,\ b \in \beta,\ c \in \gamma \Rightarrow a \leq A \leq b \leq B \leq c.$

- Rotations maintain the binary search tree property
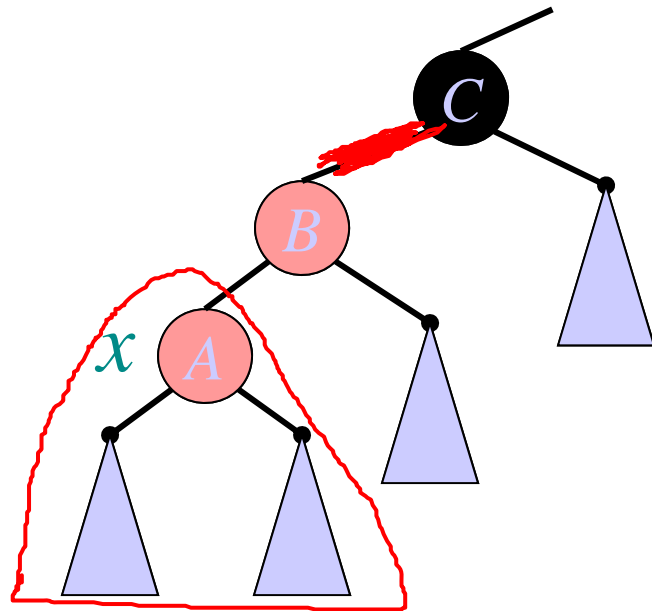- A rotation can be performed in $O(1)$ time.
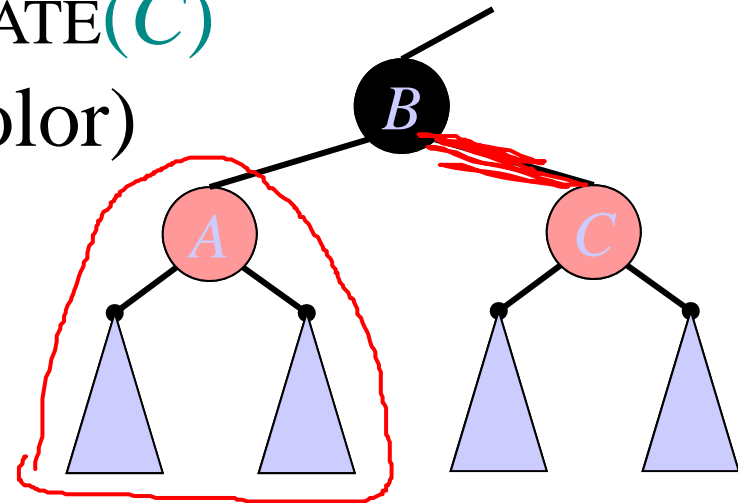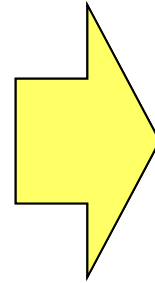
Case 2

LEFT-ROTATE(*A*)

Transform to Case 3.

$p[x] = left[p[p[x]]]$

$y \leftarrow right[p[p[x]]]$

$color[y] = \text{BLACK}$

$x = right[p[x]]$

Case 3

RIGHT-ROTATE(C)
(and recolor)

Done! No more violations of RB property 4 are possible.

$p[x] = left[p[p[x]]]$

$y \leftarrow right[p[p[x]]]$

$color[y] = \text{BLACK}$

$x = left[p[x]]$