Red-black tree updates
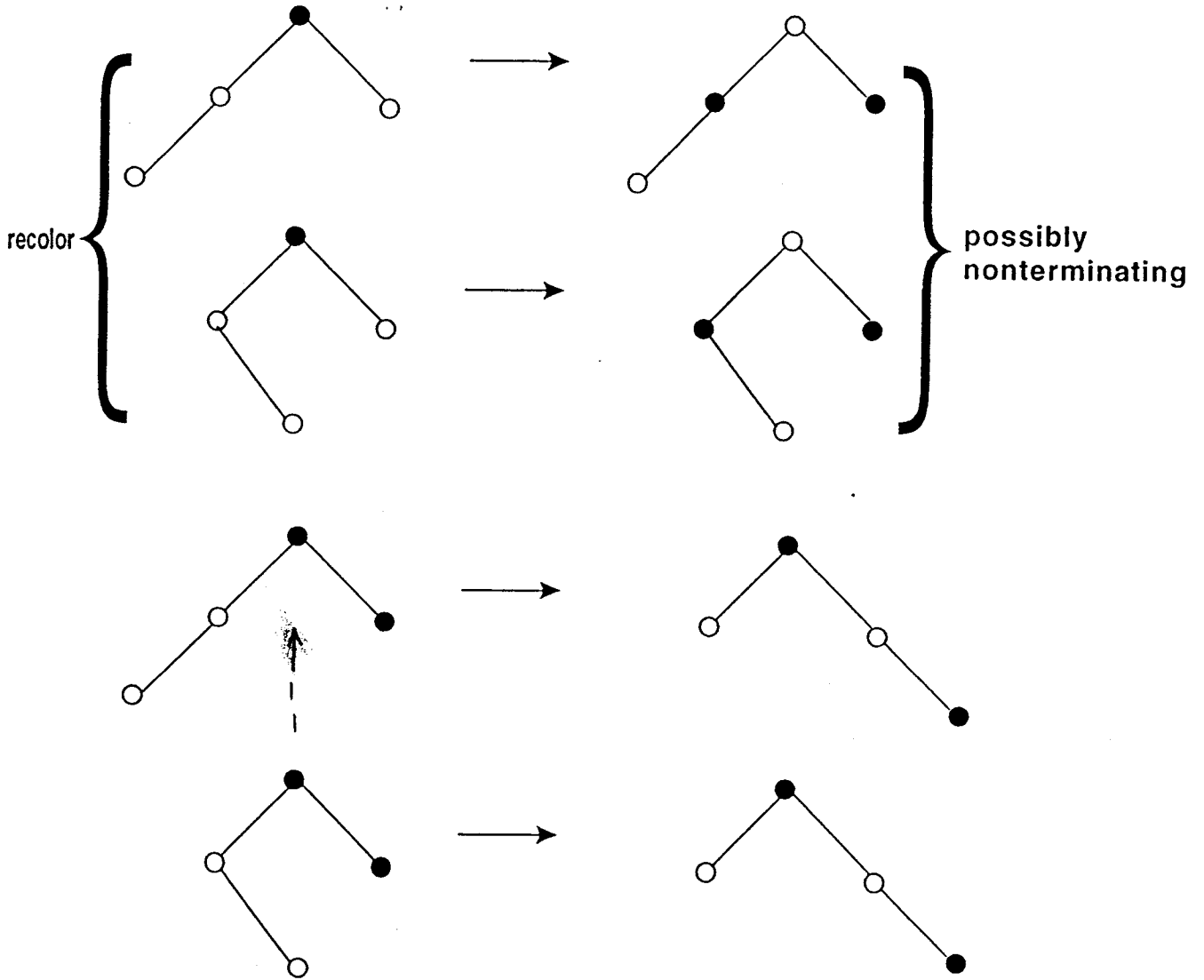
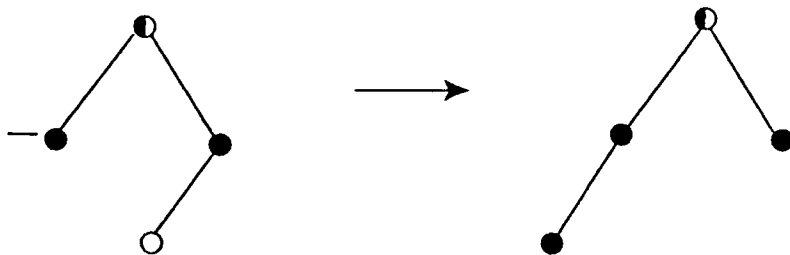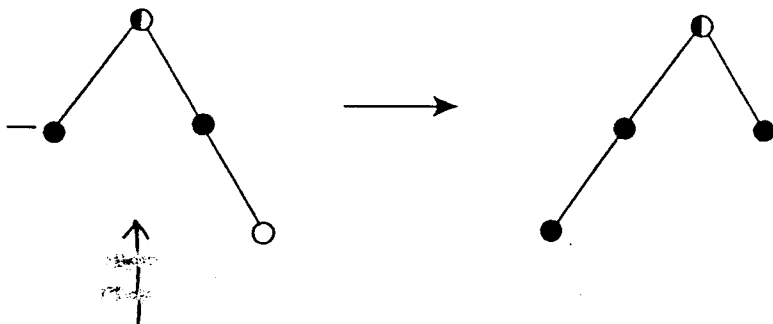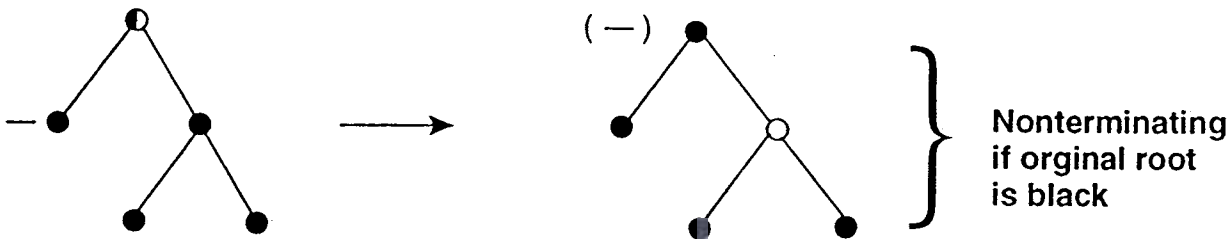- ● **black**
- ○ **red**

Insert   ○ root   ⟶   ●

recolor {

} possibly nonterminating

Delete

— short node (all paths down lack one black node)

◑ red or black node (color preserved)

—● root ⟶ ●

—○ ⟶ ●

creates a terminating case

Nonterminating if orginal root is black
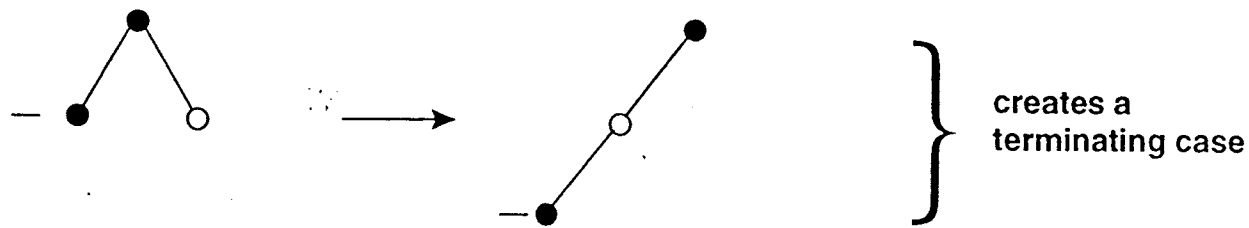
O(log n) recolorings; 0, 1, 2, or 3 rotations

O(1) amortized recoloring time for insert/delete:

$\Phi = 2$ for ○○,   1 for ●◑