Red black tree

# Definition

* Root and NIL == black // If (Z == root) { colour\_black(Z) }
* If (node == red) { node.children == black }  
  - Red follows red 🡪 Violation (check Insertions)  
  - Black follows black 🡪 No violation

# Rotation

* Rotate\_left(X): Structure of X.left stays, but X.right needs readjustment
* Rotate\_right(X): Structure of X.right stays, but X.left needs readjustment

# Insertion

Define Z = inserted red node OR resulted problem node  
Triangle/Line = Z, Parent and Grandparent form a triangle/line

1. If (Z.uncle == red) { recolour(parent, uncle, grandparent) }
2. If (Z.uncle == black, AND triangle) { rotate(parent) }
3. If (Z.uncle == black, AND line) { rotate(grandparent); recolour(parent, grandparent) }

## Exercise

1. case 1: If (Z.uncle == red) { recolour(parent, uncle, grandparent) }  
   Define Node 12 == new Z
2. case 2: If (Z.uncle == black AND triangle) { rotate(parent) }  
   Define Node 15 == new Z
3. case 3: If (Z.uncle == black AND line) { rotate(grandparent); recolour(parent, grandparent) }

