#g   A B C D E F G H

2 - 3 - 4   R-B Tree

⊘ Black
O Red

I   [A]   ⊘ A

II   [A | B]   A
                                                 ⊘ — B
                                                     O

III   ↑
                 [A | B | C]   gp A ⊘   UNCLE=NULL   B
                 ～   B   OR 1   ⊘
                                                 O C   → Promote P   A   C
                                                   O   G→R
                                                            P→B
                                                            U→B

IV   [B]   B gp   UNCLE=RED   B
                   [A]   [C|D]   ⊘   C   A ⊘ C
                                              A O   O P   G→R   O   ⊘
                                              U   O D   P→B   O D
                                                                     U→B

V   ↑   B   UNCLE=NULL   B
              [B]   [C|D|E]   A ⊘ C   OR 1   A ⊘ D
             [A]   ～   O   ⊘ GP   → Promote P   O   ⊘ E
                                                  O D ↑   Recolor   O C O
                                              Parent O E   G→R
                                                     O Child   P→B
                                                                 U→B

VI   [B|D]   B   UNCLE RED   B
              [A] [C] [E|F]   A ⊘ D GP   A ⊘ D
                                              O   ⊘   G→P   G→R   O ⊘ C O E
                                                  O C O   P→B   O   ⊘ F
                                                      O F   U→B   O

VII   [B|D]   B   UNCLE NULL   B
             [A] [C] [E|F|G]   A ⊘ D   A ⊘   D
                                               O   O E   → Promote P   O   O   F
                                               C ⊘   ⊘   &   C ⊘ E G
                                                    O F   Recolor   ⊘ ⊘
                                                     O G   O O

              [B|D|F]   B - GP

√(11)
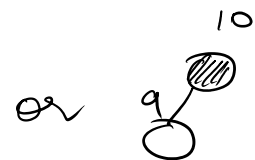

B-GP

Parent Child

UNCLE RED
reeolor →

U → B
Promote P
Recolor
G → R
P → B

D
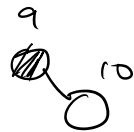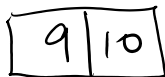
Possible to map any 2-3-4 tree into a
R-B - Tree.

•₁   2- node

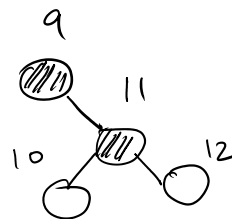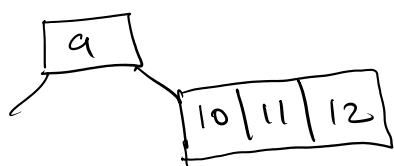9

•₂   3- node

9 | 10

9 ──10   or   10 / 9

•₃   4- node

9 | 10 | 11

10 / 9 \ 11
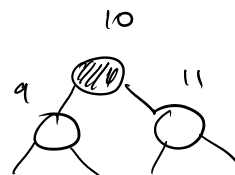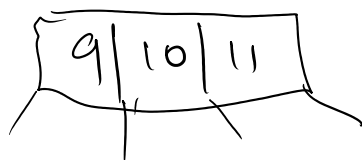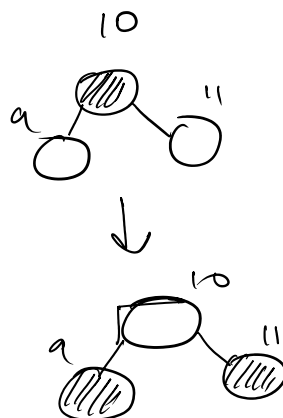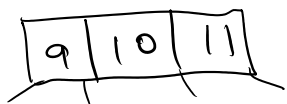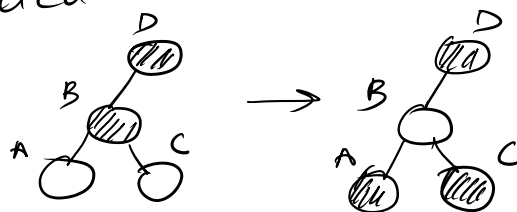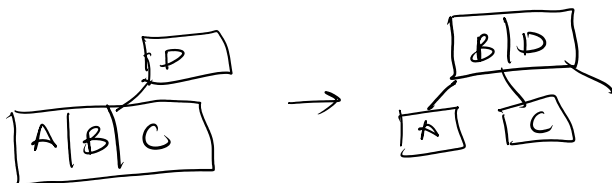
• 4   2-node is connected to 4-node
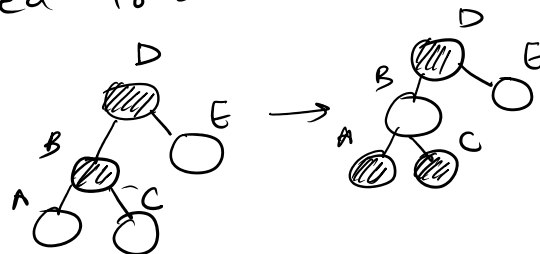

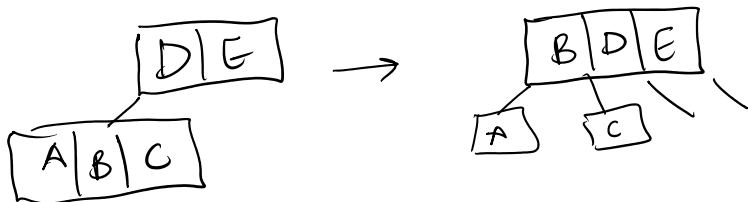• 5   Splitting a 4-node

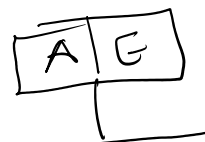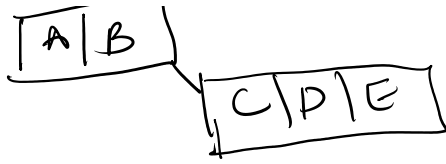
• 6   Split a 4-node connected to a 2-node

• 7   Split a 4-node connected to a 3-node

or

```
 ┌───┬───┐
 │ A │ B │
 └───┴───┘
        ┌───┬───┬───┐
        │ C │ D │ E │
        └───┴───┴───┘
```

or

```
 ┌───┬───┐
 │ A │ E │
 └───┴───┘
     ┌───┬───┬───┐
     │ B │ C │ D │
     └───┴───┴───┘
```