

# Assignment 8

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Course name: Data Structures

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## HW 8

# Red-Black Tree Insert and Delete

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- Insert

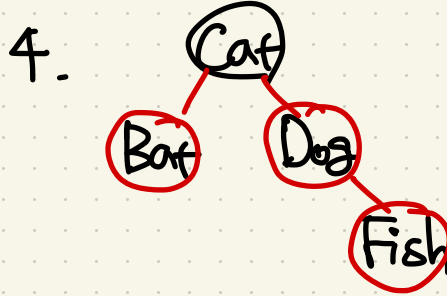
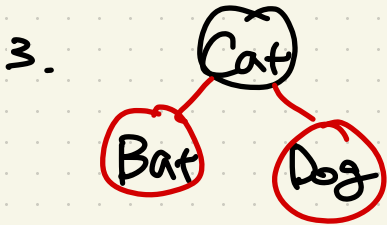
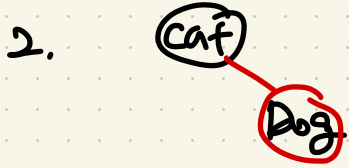
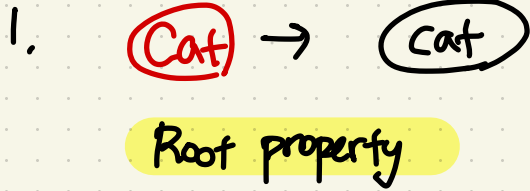
- Cat Dog Bat Fish Chicken Cow Tiger Eagle  
Lion Snake Bird Owl Mouse

- Delete

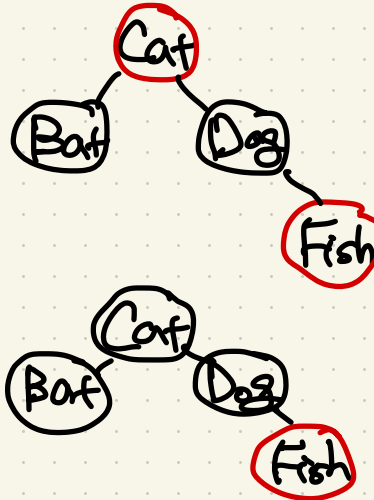
- Cow Snake Owl Cat Mouse Eagle Bird

## Insert

- Cat Dog Bat Fish Chicken Cow Tiger Eagle  
Lion Snake Bird Owl Mouse



Double Red  
→ Recoloring

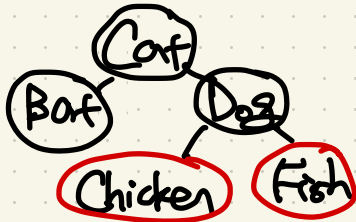


Root Red  
→ Root Property

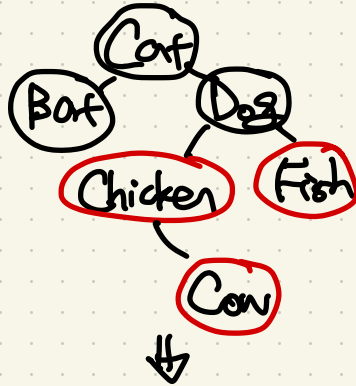
## Insert

- Cat Dog Bat Fish Chicken Cow Tiger Eagle  
Lion Snake Bird Owl Mouse

5. Chicken

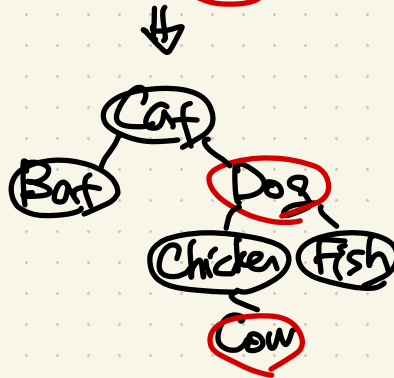


6. Cow

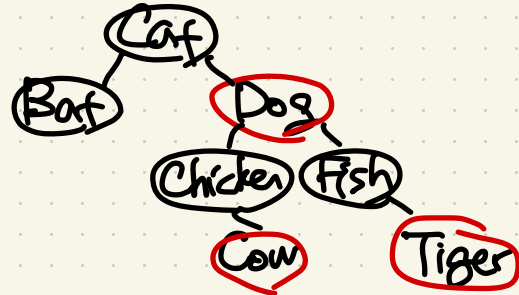


→ Double Red!

→ Recoloring



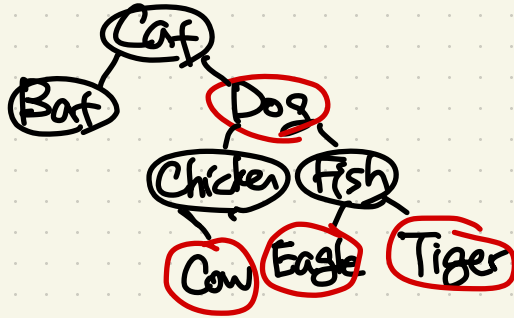
7. Tiger



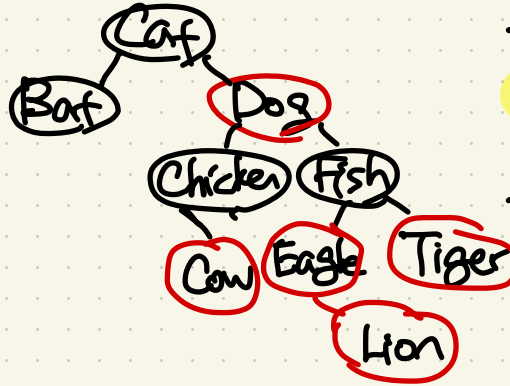
## Insert

- Cat Dog Bat Fish Chicken Cow Tiger Eagle
- Lion Snake Bird Owl Mouse

8. Eagle

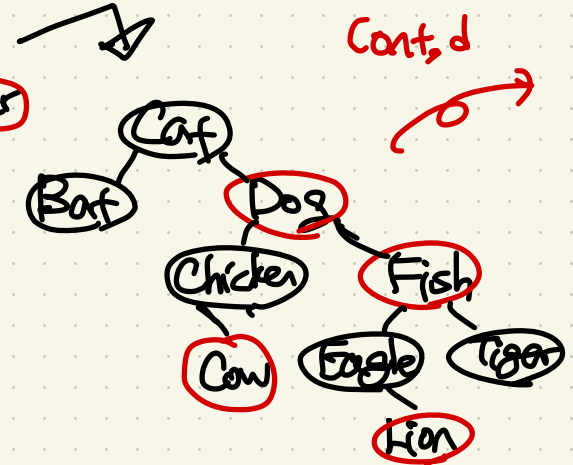


~~9.~~ Lion



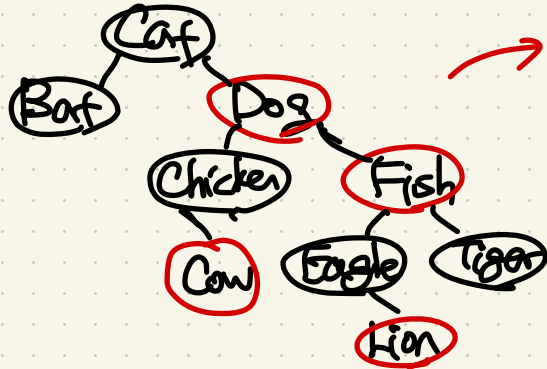
→ Double Red!

→ Recoloring

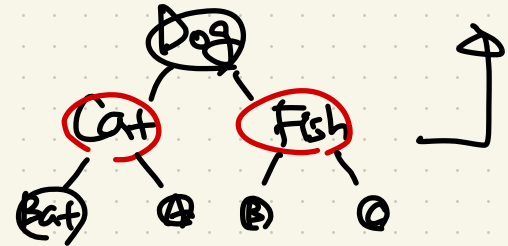
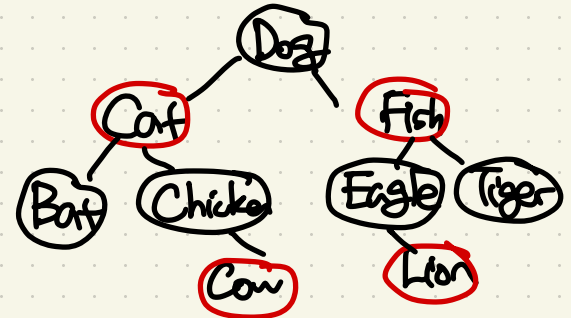
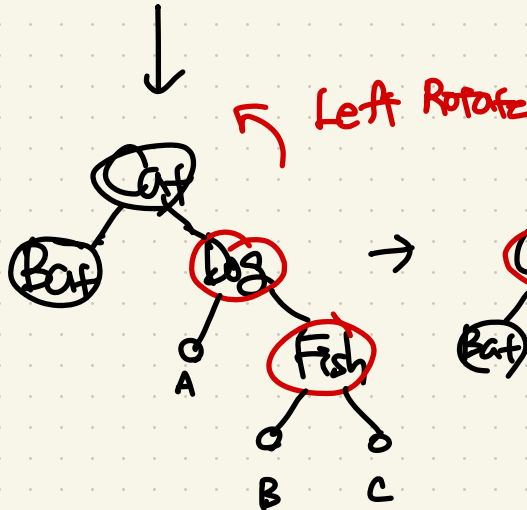


## Insert

- Cat Dog Bat Fish Chicken Cow Tiger Eagle  
Lion Snake Bird Owl Mouse



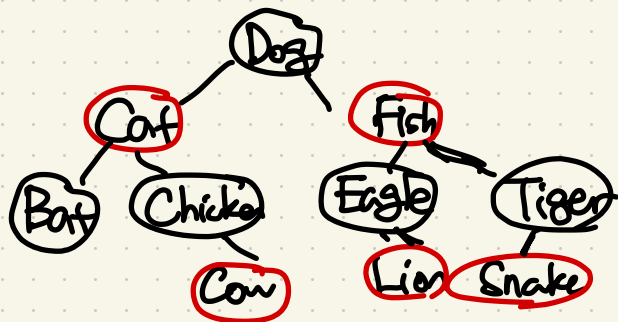
Double Red  
Restructuring



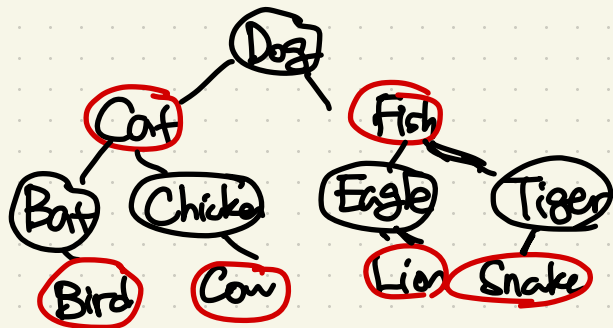
## Insert

- Cat Dog Bat Fish Chicken Cow Tiger Eagle  
Lion Snake Bird Owl Mouse

10. Snake



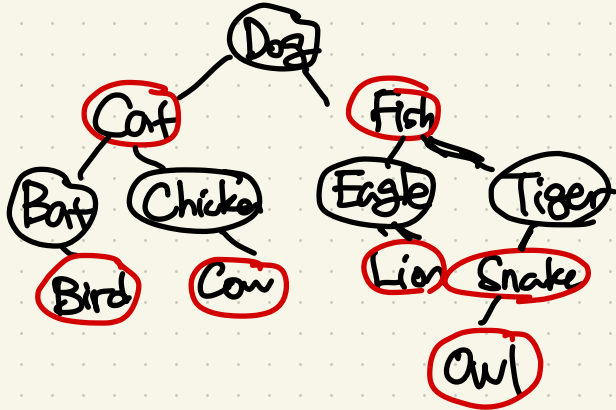
11. Bird



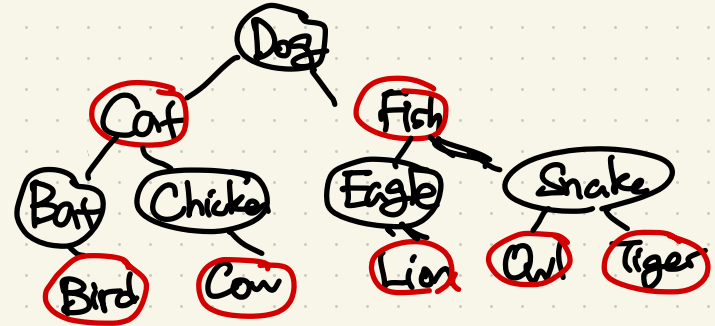
## Insert

- Cat Dog Bat Fish Chicken Cow Tiger Eagle  
Lion Snake Bird Owl Mouse

12. Owl

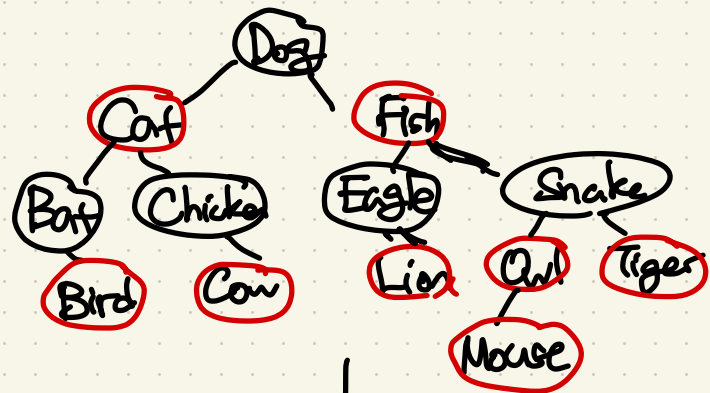


→ Double Red  
R-rotate



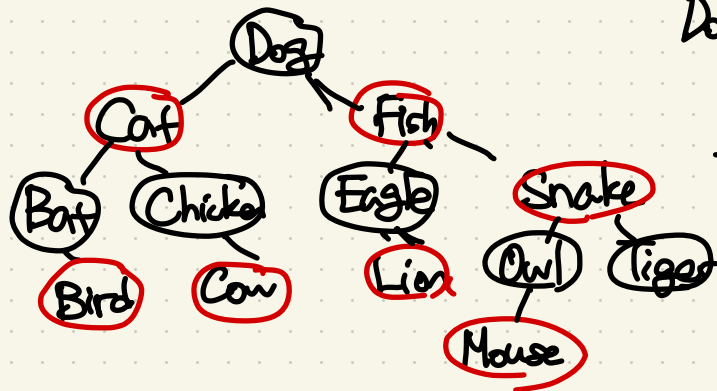
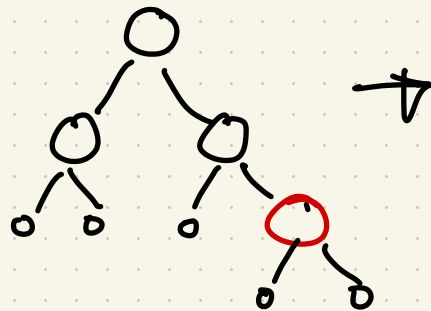


## B. Mouse

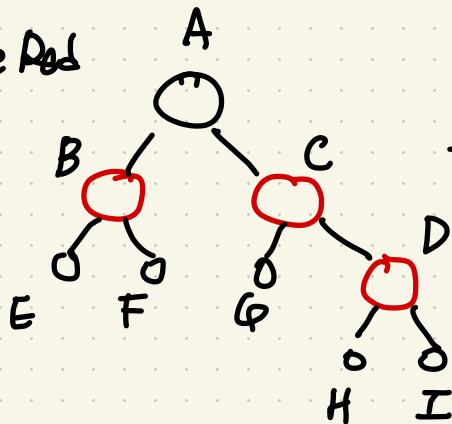


Double red

Recoloring

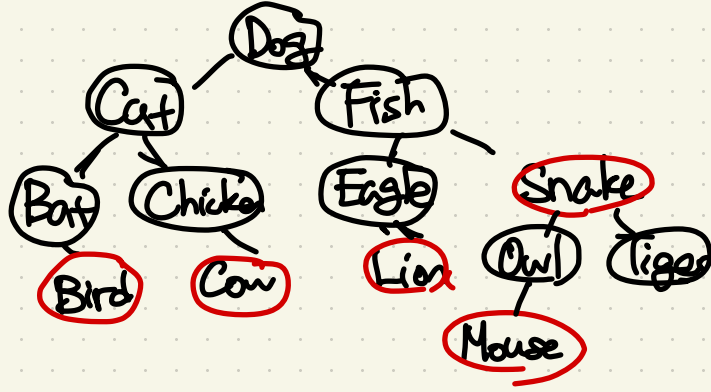


Double Red



Recoloring

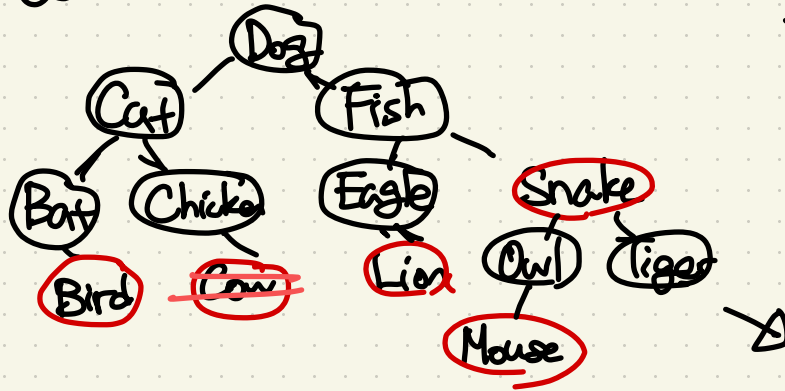
## Insertion Result!



## ■ Delete

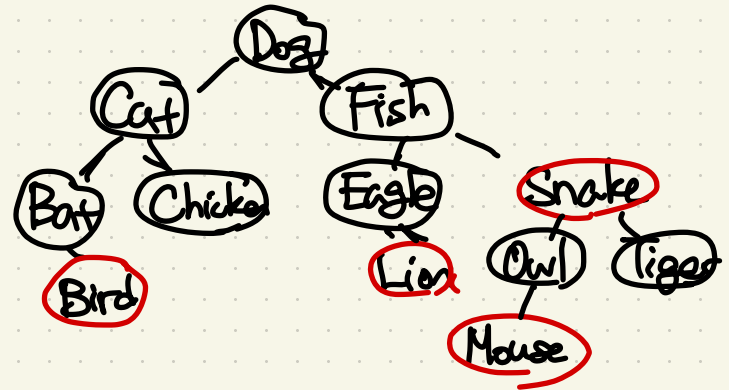
■ Cow Snake Owl Cat Mouse Eagle Bird

1. Cow



Delete red-leaf.

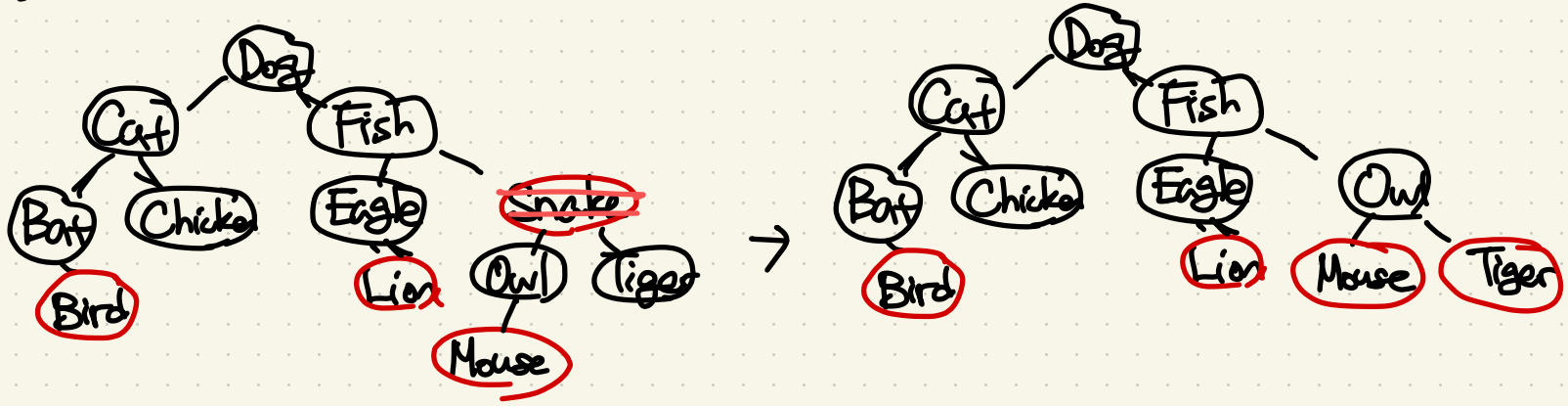
just delete



## ■ Delete

■ Cow Snake Owl Cat Mouse Eagle Bird

2. Snake



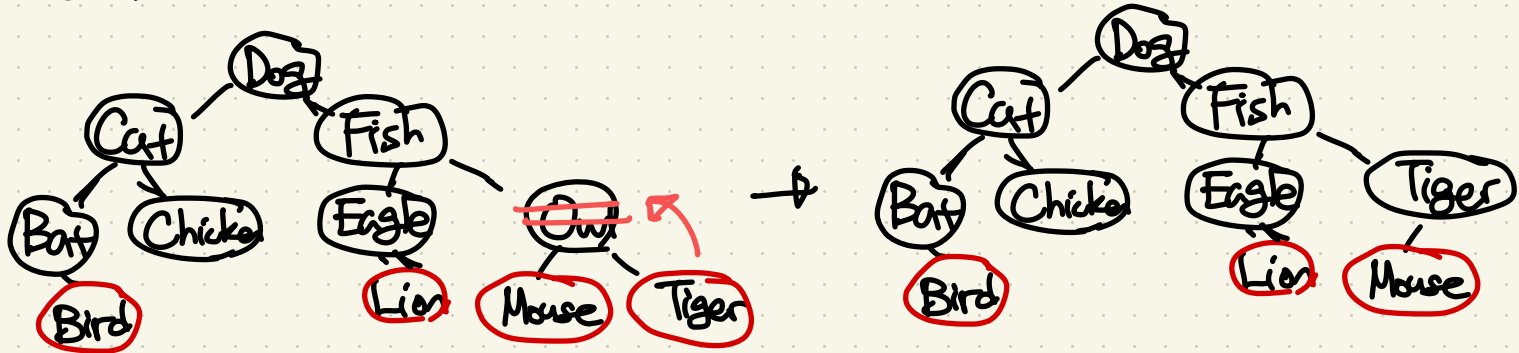
└ Delete Red-node, non-leaf

replace it with black

## ■ Delete

■ Cow Snake Owl Cat Mouse Eagle Bird

### 3. Owl

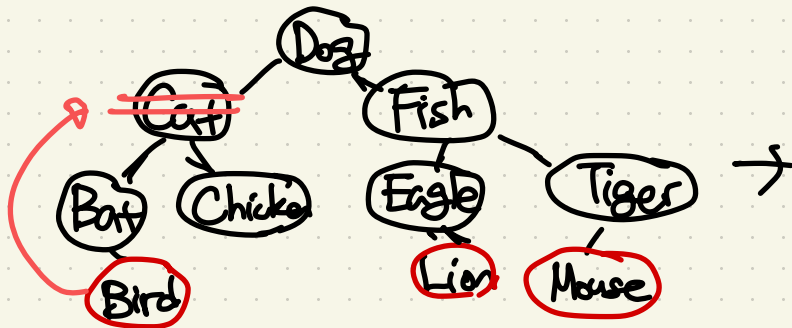


As Tiger is not black, no double black occurs

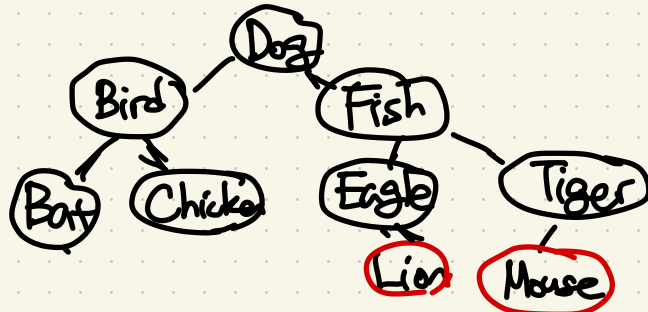
## ■ Delete

■ Cow Snake Owl Cat Mouse Eagle Bird

### 4. Cat

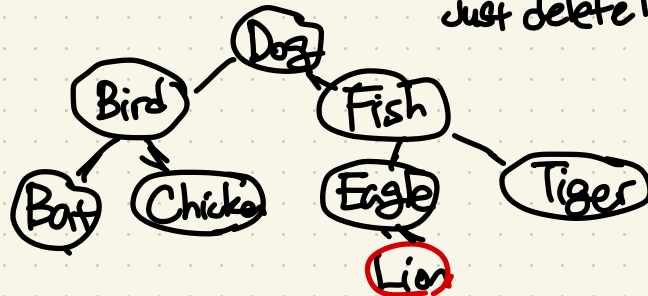


As Bird is not black, so no double black.  
just change the color of Bird!



### 5. Mouse

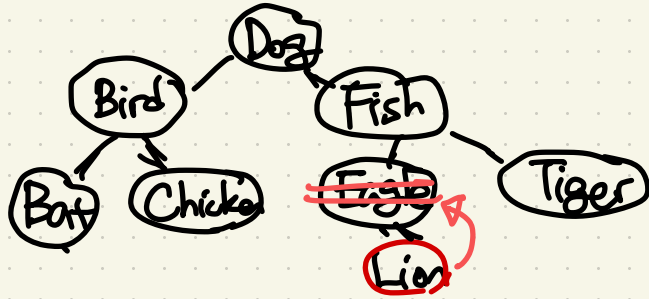
Red-leaf node  
just delete!



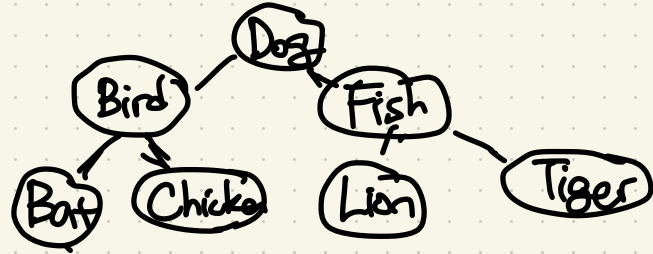
## ■ Delete

■ Cow Snake Owl Cat Mouse Eagle Bird

6. Eagle



→

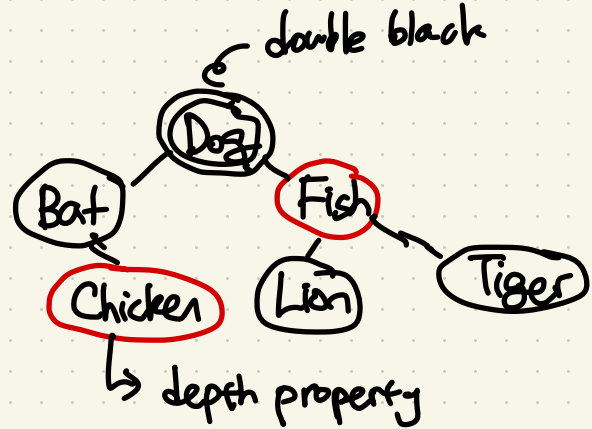
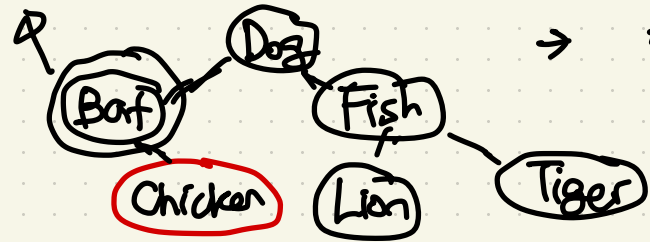
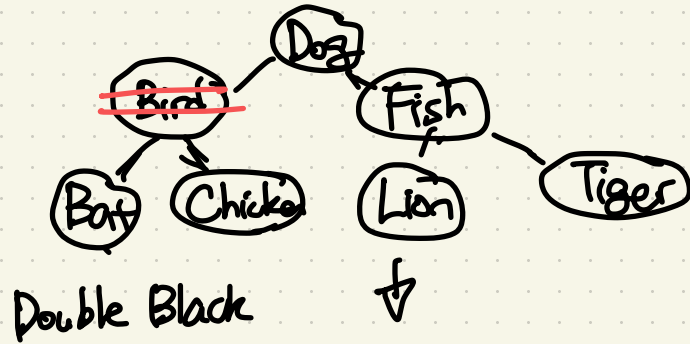


Lion is red, so just change color of Lion to black

## ■ Delete

■ Cow Snake Owl Cat Mouse Eagle Bird

### 7. Bird



→ As Bat's sibling is black and sibling's descendant are all black, so change the color of sibling red and deliver black to Bat's parent.