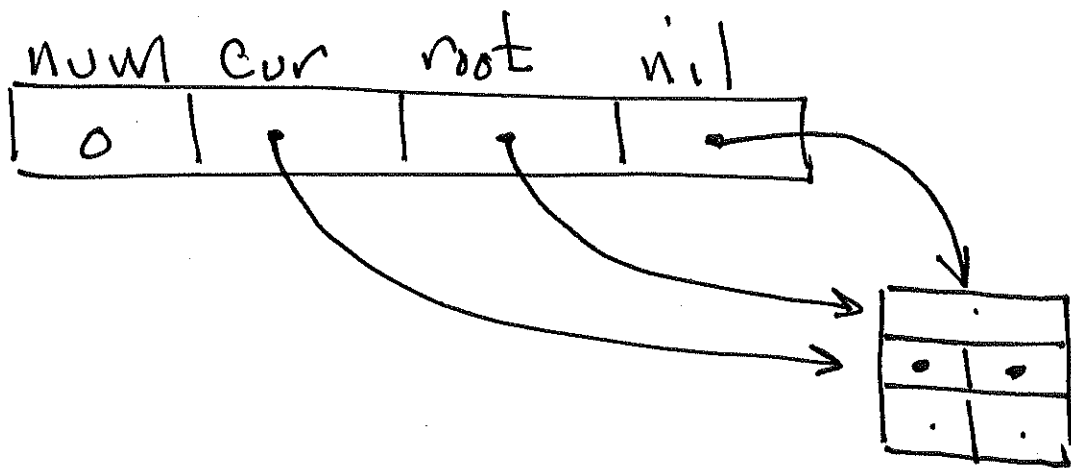


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1

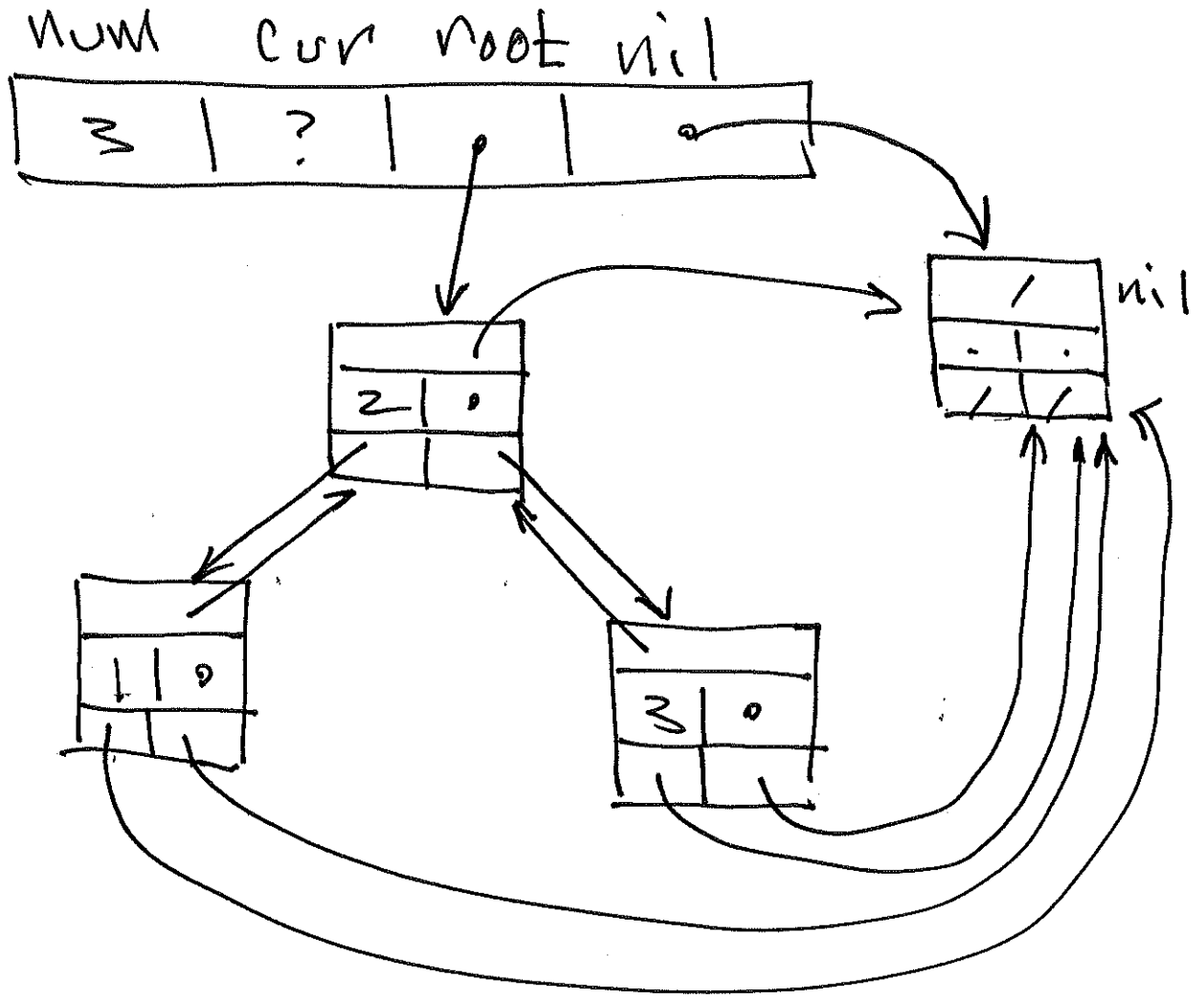
- Pat: ext. 2 days.

Dictionary Empty state:

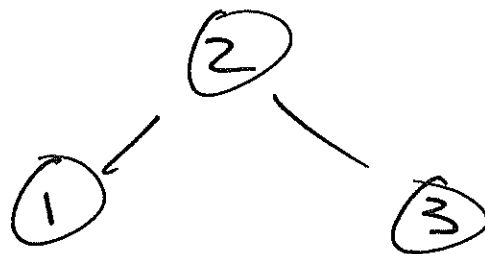


Dictionary non-empty state!

inside



client



$\{(1, \cdot), (2, \cdot), (3, \cdot)\}$

Forward & backward iteration

Analogy

List Pal

Dictionary Pal

moveFront() - - - - - begin()

moveBack() - - - - - end()

get() - - - - - { currentKey()
currentVal()

moveNext()

next()

movePrev()

prev()

helper

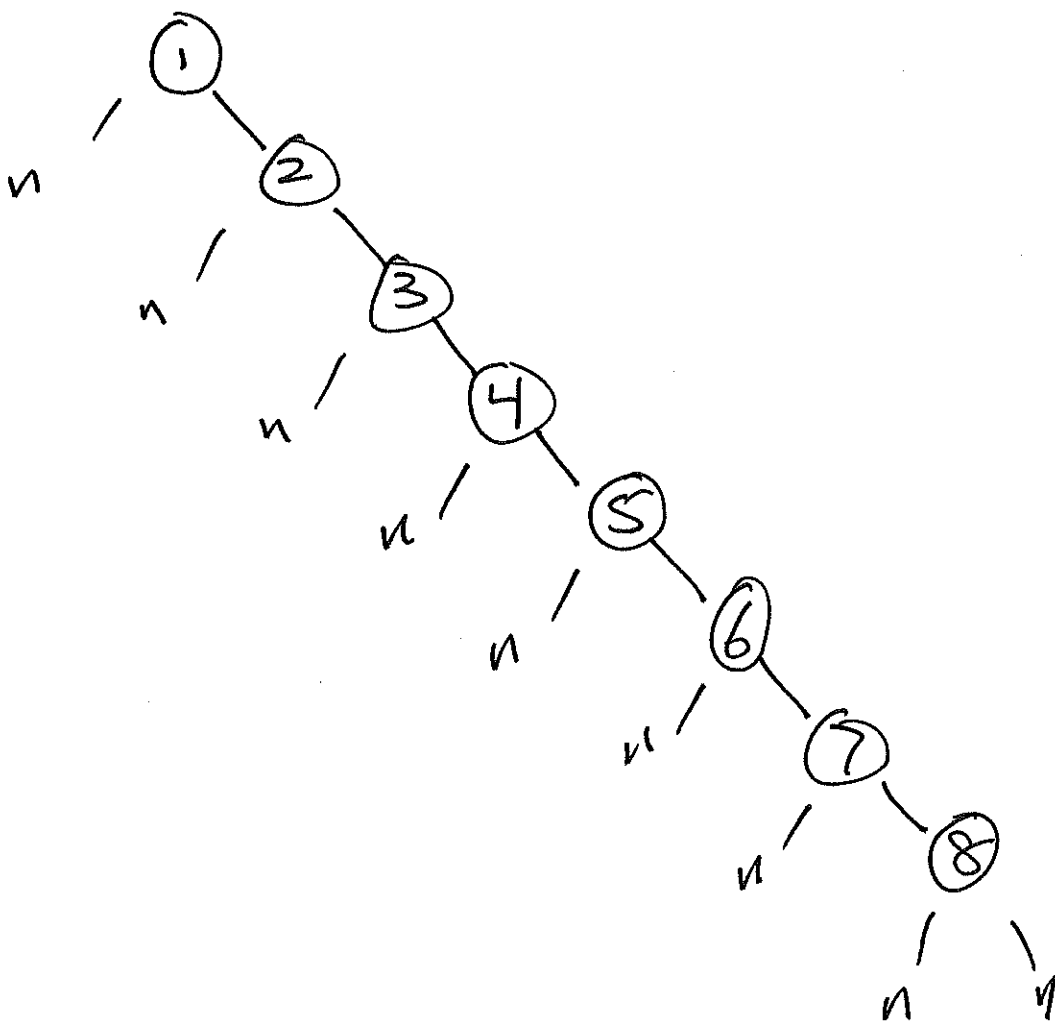
inOrderString() $\rightarrow$ to_string()

inOrderString() $\rightarrow$ equals()

PreOrderCopy $\rightarrow$ copy const.

Problem with BST dictionary

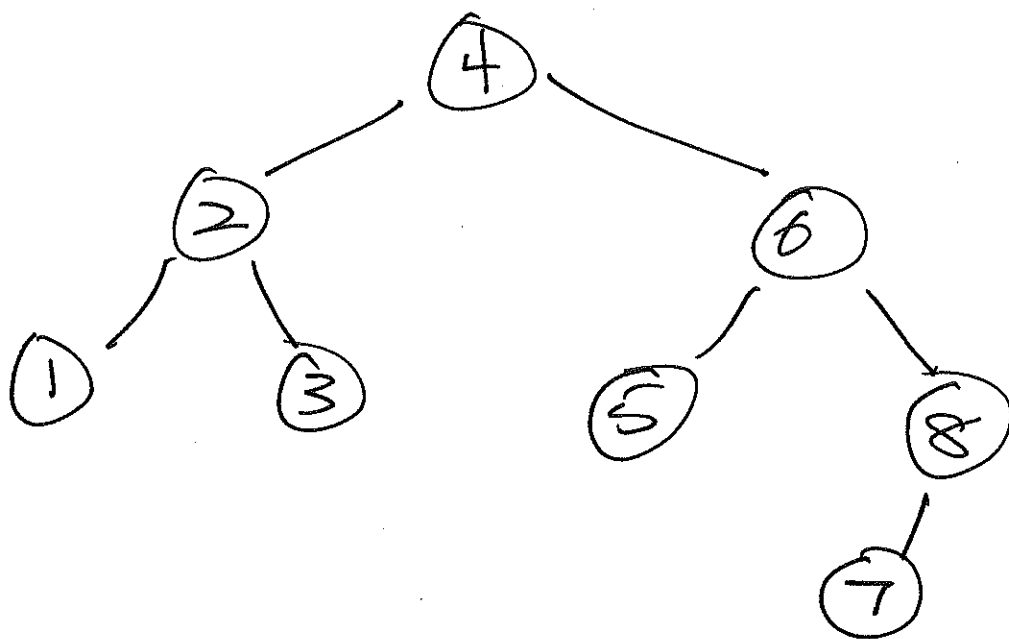
Ex. Insert Keys: 1, 2, 3, 4, 5, 6, 7, 8



Ex.

4, 2, 1, 3, 6, 5, 8, 7

6



Solution Red-Black Tree

13.1 RBTs

Defn A RBT is a BST that also satisfies RBT Properties

Convention

The leaves in RBT are the nil children of key-bearing nodes

RBT Properties

- 1.) Each node is Red or Black.
- 2.) The root is Black.
- 3.) Each leaf (i.e. nil) is Black.
- 4.) Every Red node has 2 Black children (possibly nil).
i.e. any line of ancestry does not contain 2 Reds in a row.
- 5.) For any node x , any descending path from x to a leaf has the same number of Black nodes.

Defn

The Black height of x

$bh(x)$

is the # of black nodes
from x to a descendant leaf.
(not counting x itself.)

Note: $height(x)$ denotes ordinary
(absolute) height.

Ex.

