CSI 2110 Tutorial (Section A)

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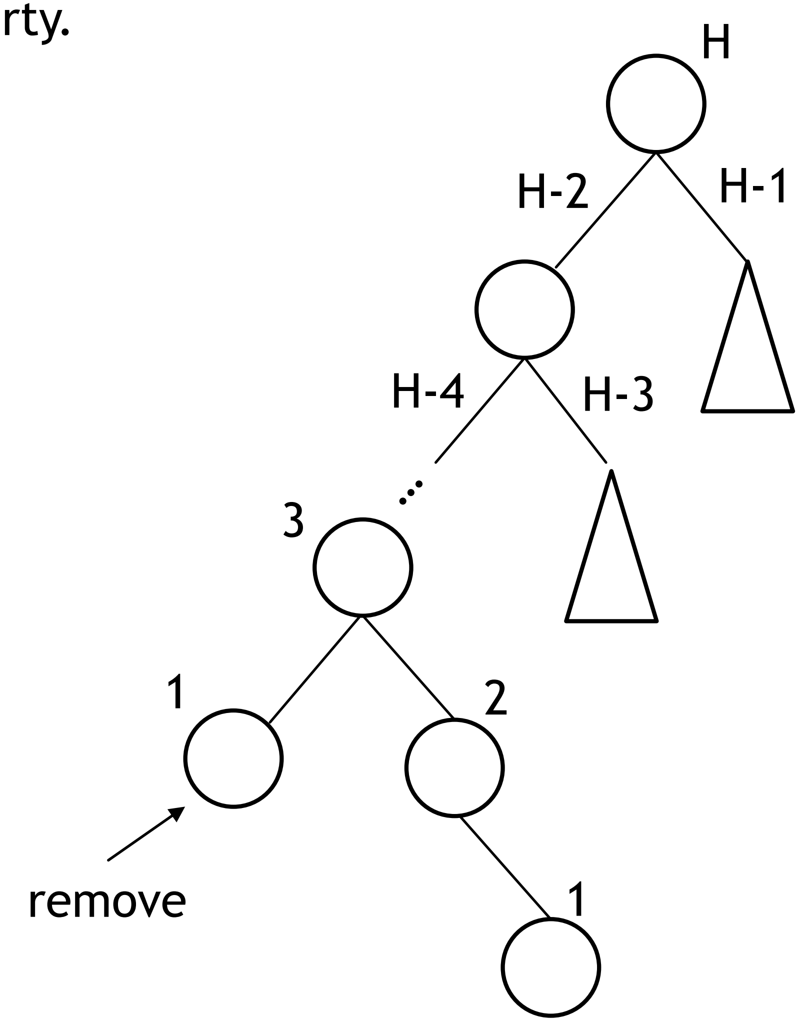
Office Hour: Fri 13:00-14:00
Place: STE 5000G

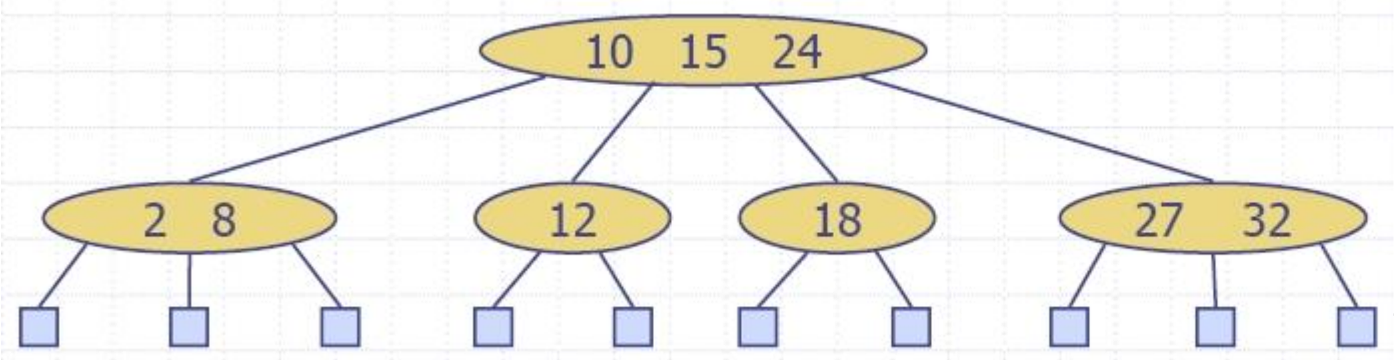
Previous Exercise

Draw a schematic of an AVL tree such that a single remove operation could require $\Omega(\log n)$ trinode restructurings (or rotations) from a leaf to the root In order to restore the height-balance property.



Review (2,4) Tree

A **multi-way search tree** such that:
- the number of children must be 2, 3, or 4.
- the number of stored elements must be d-1 (d is the number of children)
- for a node with children v1, v2, … vd, storing keys k1, k2, … k(d-1)
    - keys in the subtree of v1 are less than k1
    - keys in the subtree of vi are between k(i-1) and ki (i=2,…,d-1)
    - keys in the subtree of vd are greater than k(d-1)
- the leaves store no items and serve as placeholders
- all the external nodes have the same depth



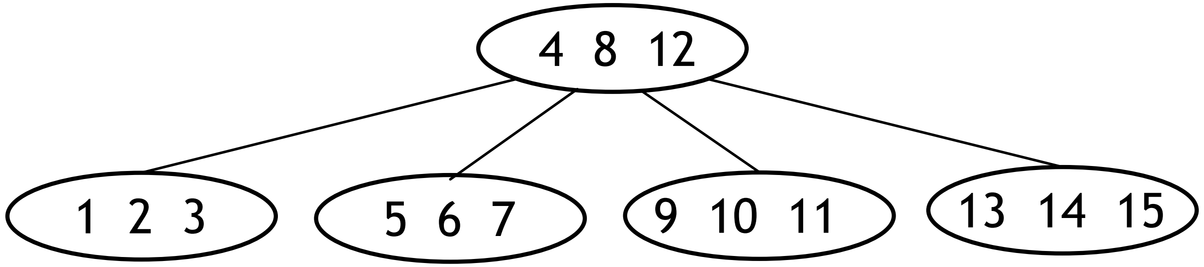
Exercise

1. Consider the set of keys k={1,2,3,4,5,6,7,8,9,10,11,12,13,14,15}.

a. Draw a (2,4) tree storing K as its keys using the fewest number of nodes

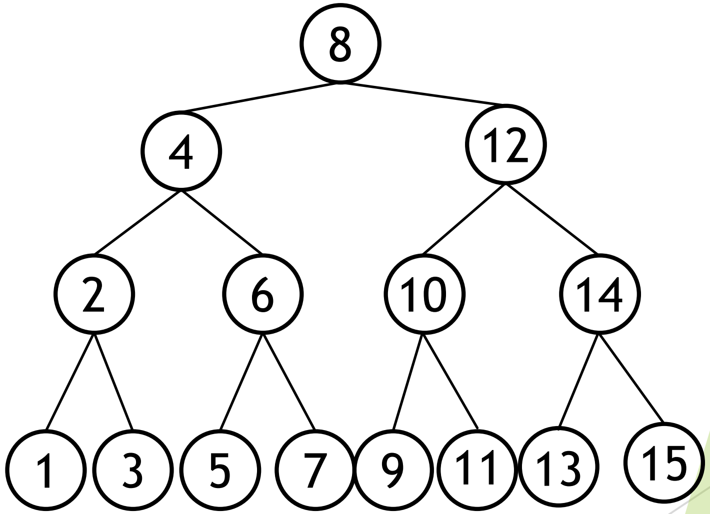
b. Draw a (2,4) tree storing K as its keys using the greatest number of nodes.

a



5 nodes

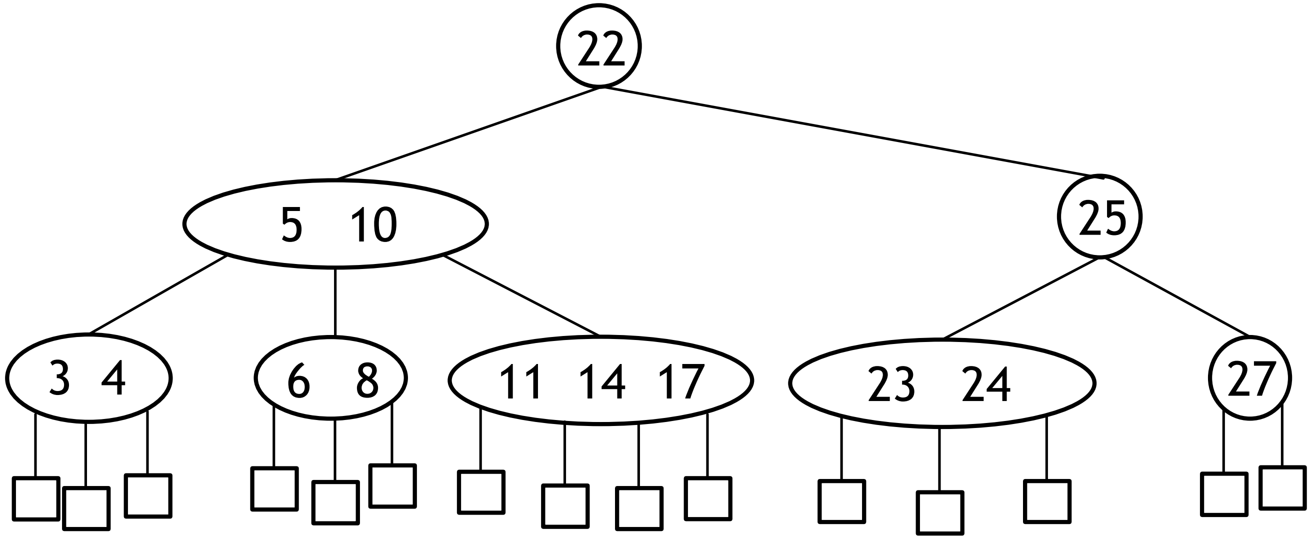
b



15 nodes

Exercise

2. Insert 15 in the tree of the picture and show the resulting tree.



Exercise

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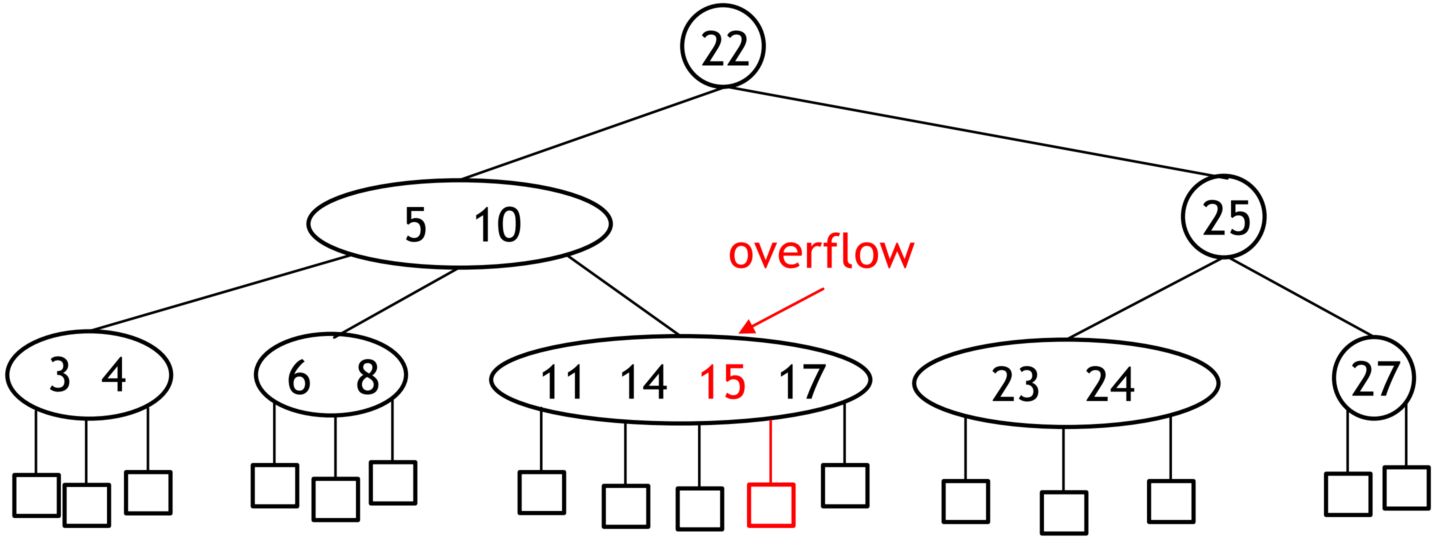

Exercise

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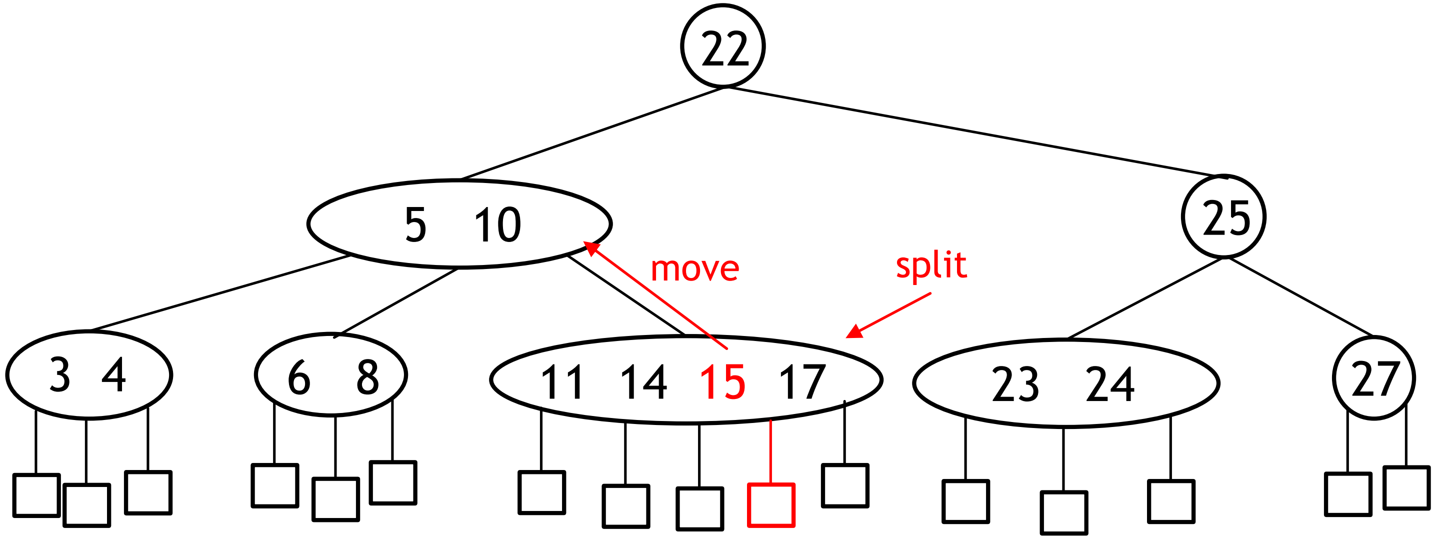
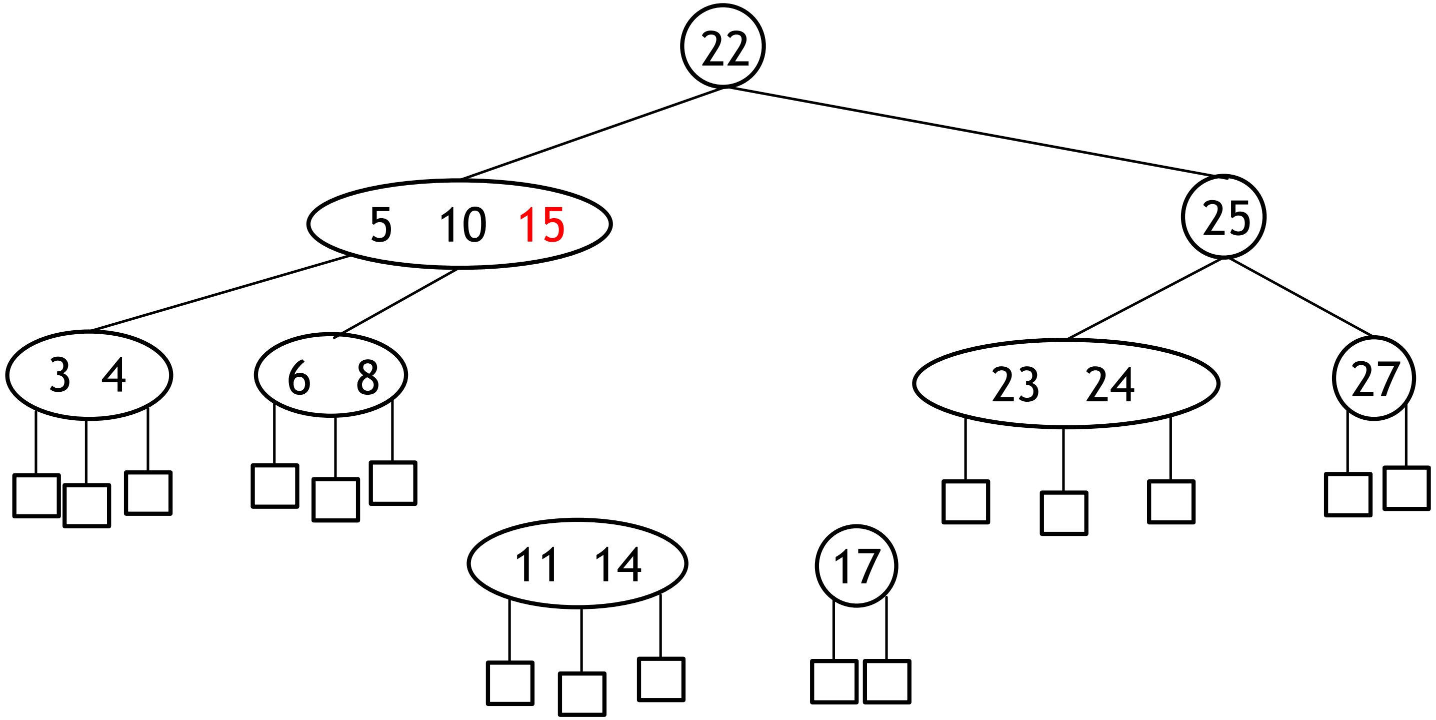


Split the node to 3-node and 2-node
Move the third element to parent

Exercise

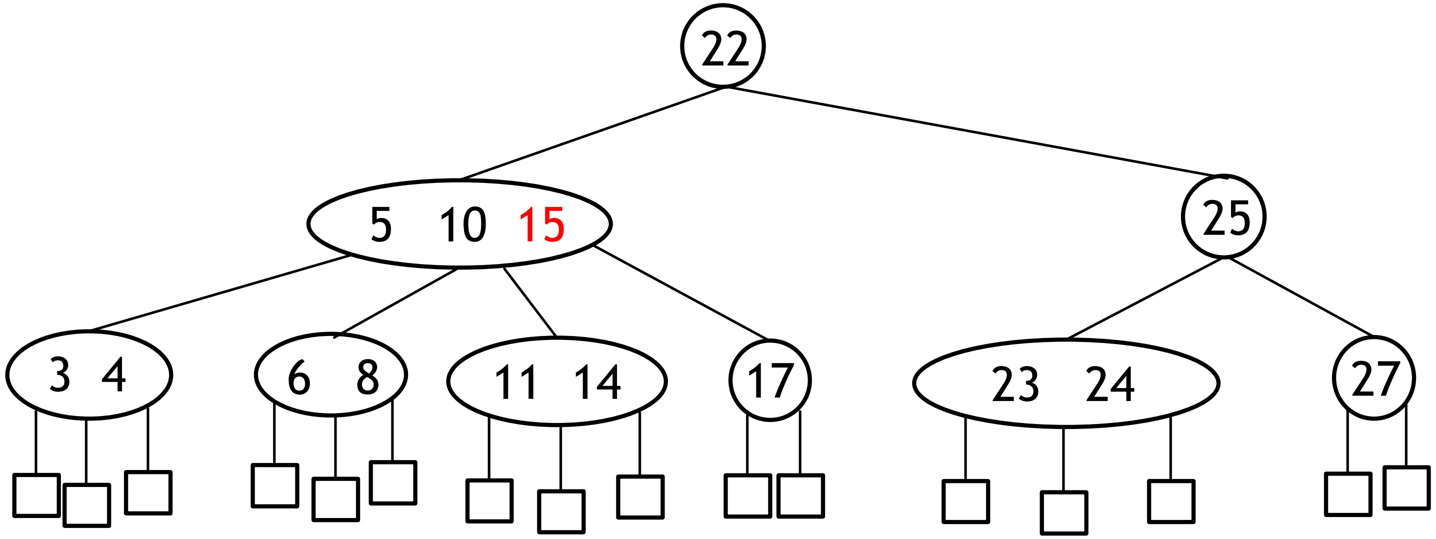
2. Insert 15 in the tree of the picture and show the resulting tree.



Link 3-node and 2-node to parent

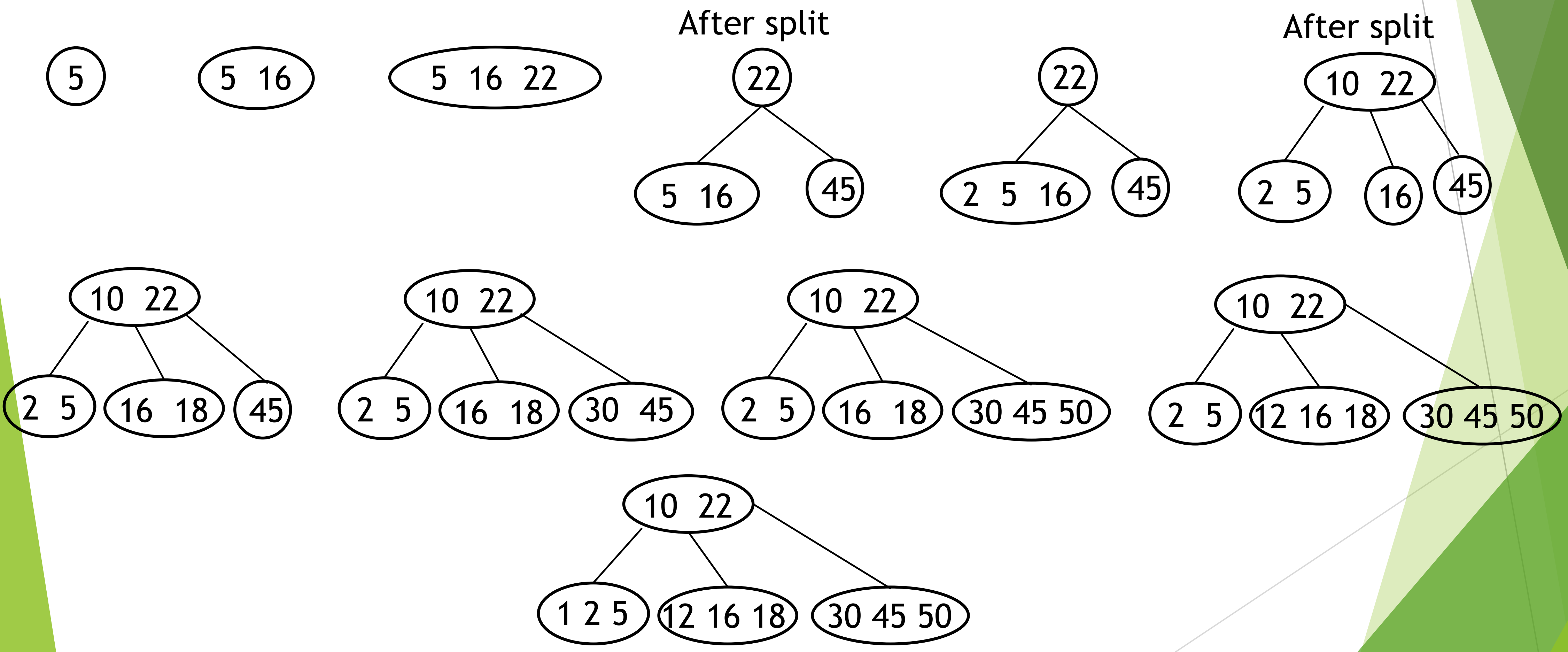
Exercise

2. Insert 15 in the tree of the picture and show the resulting tree.



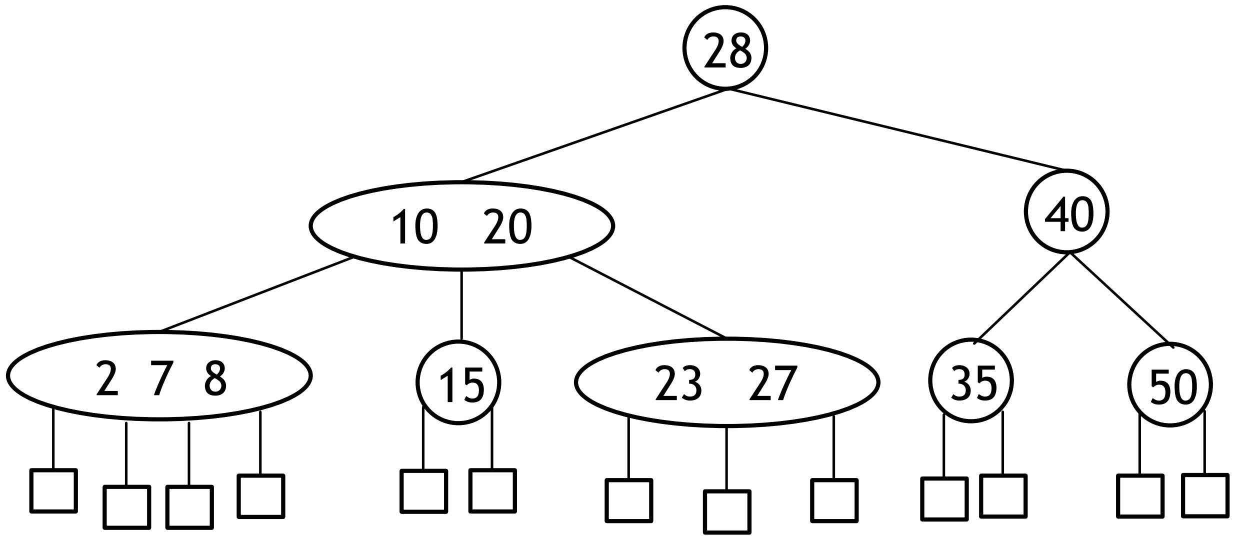
Exercise

3. Consider the sequence of keys (5,16,22,45,2,10,18,30,50,12,1). Draw the Result of inserting entries with these keys (in the given order) into an initially Empty (2, 4) tree



Exercise

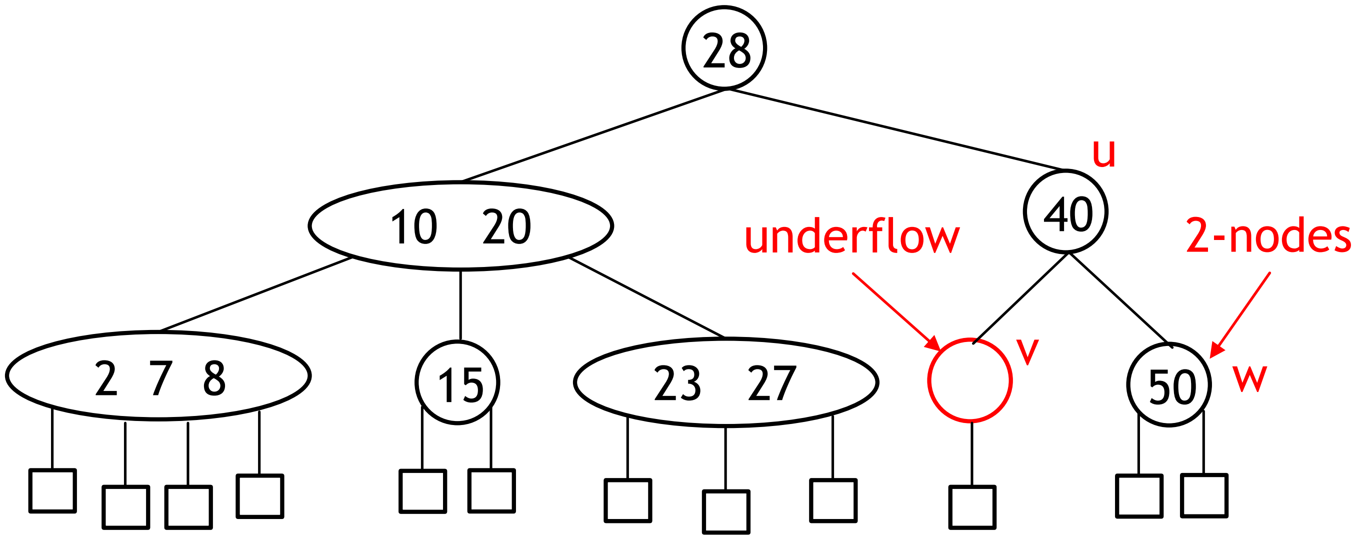
4. Delete 35 from the following (2,4) tree. Draw the resulting tree after rebalancing (if necessary)



Exercise

4. Delete 35 from the following (2,4) tree. Draw the resulting tree after rebalancing (if necessary)

Case 1: adjacent siblings are 2-nodes

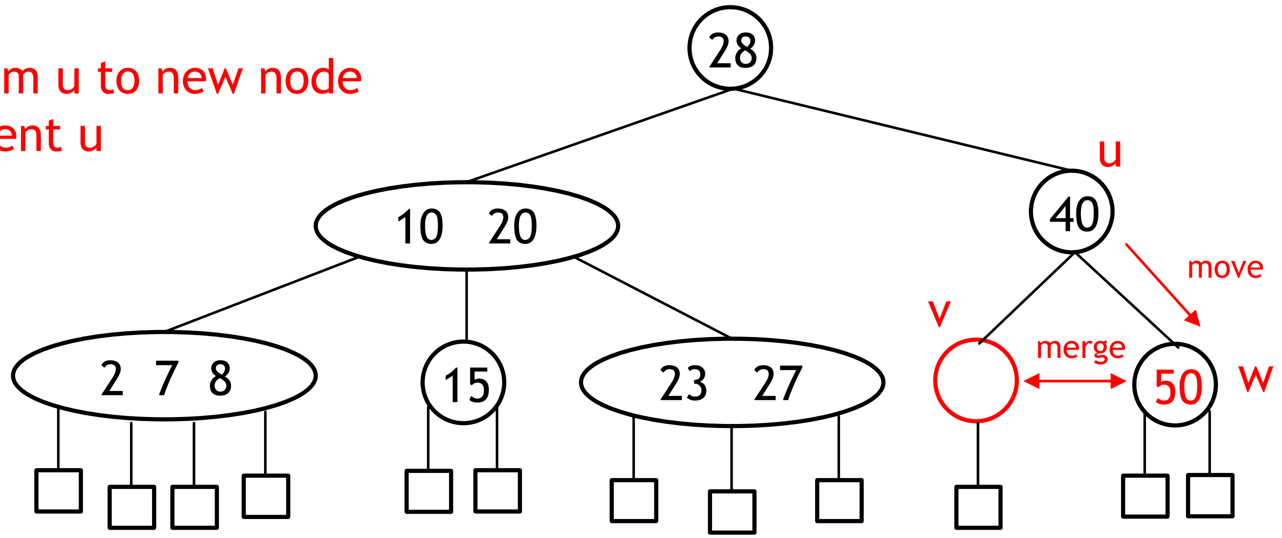


Underflow: node becomes a 1-node with one child and no keys

Exercise

4. Delete 35 from the following (2,4) tree. Draw the resulting tree after rebalancing (if necessary)

Case 1: adjacent siblings are 2-nodes
- merge v and w
- move an item from u to new node
- propagate to parent u



Exercise

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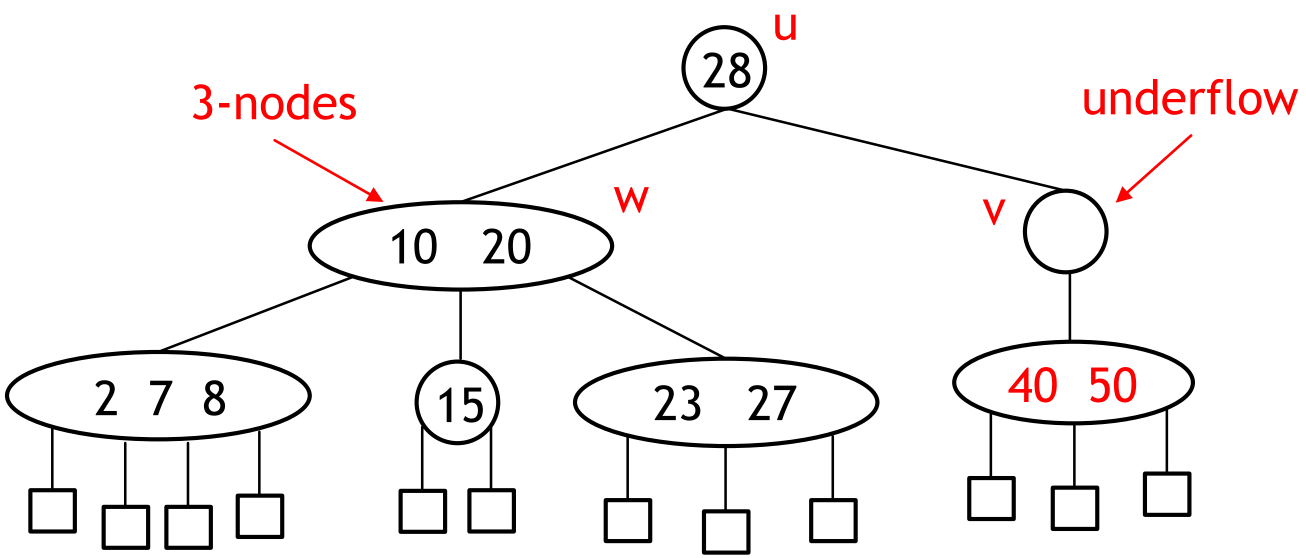
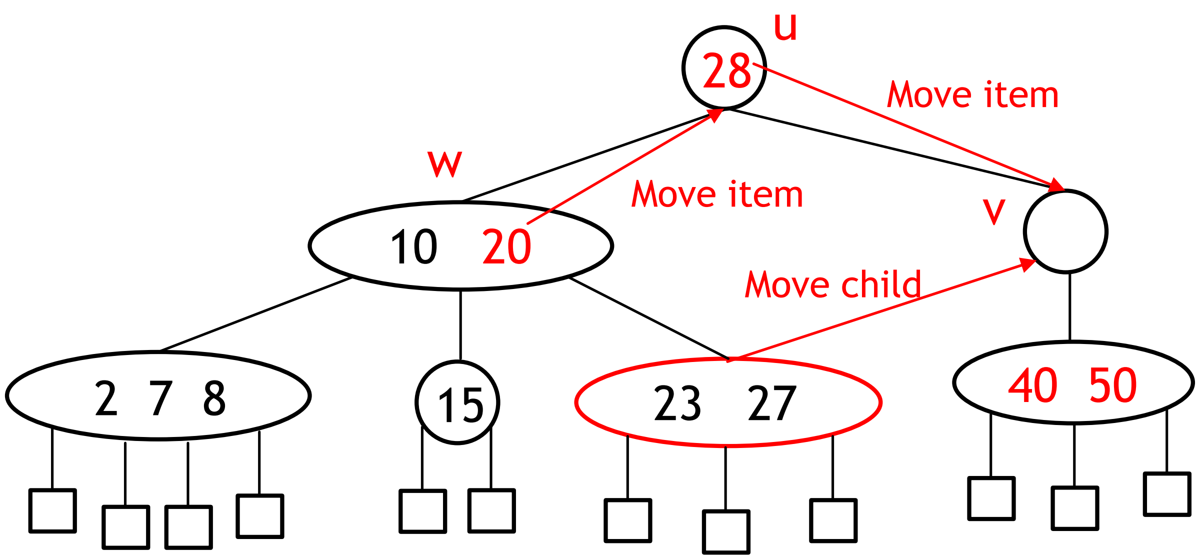


Case 2: adjacent siblings are 3-nodes or 4-nodes

Exercise

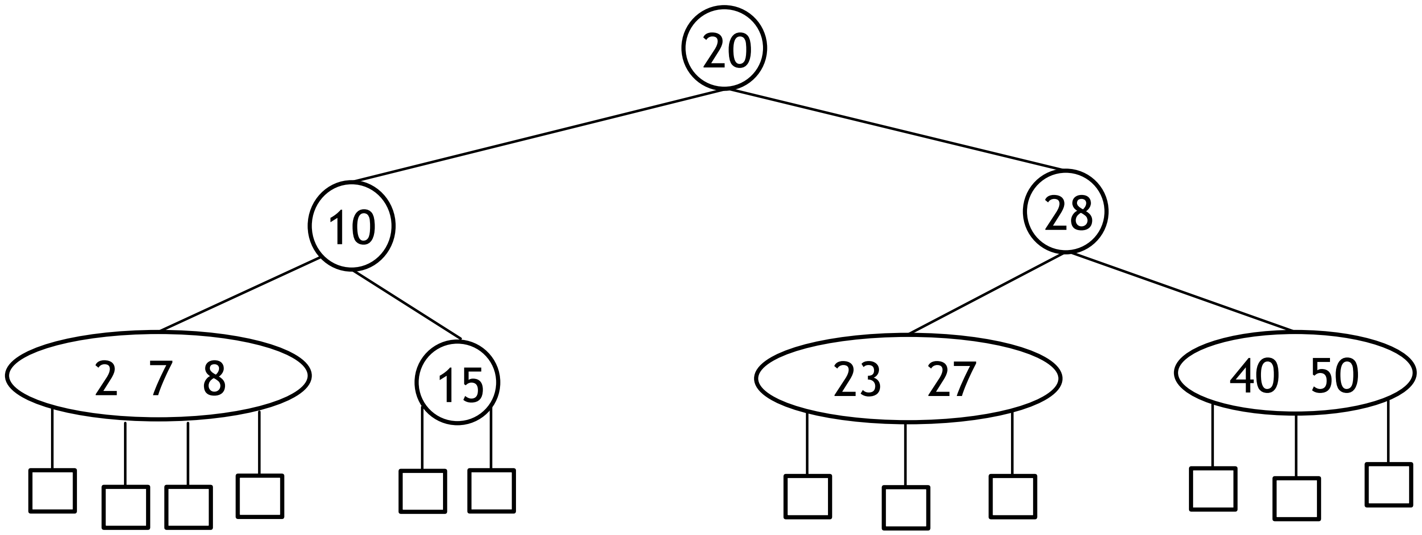
4. Delete 35 from the following (2,4) tree. Draw the resulting tree after rebalancing (if necessary)



Case 2: adjacent siblings are 3-nodes or 4-nodes
- move a child of w to v
- move an item from u to v
- move an item from w to u

Exercise

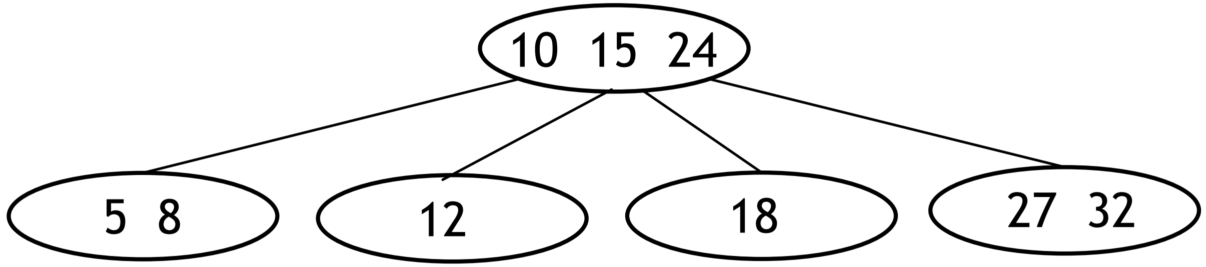
4. Delete 35 from the following (2,4) tree. Draw the resulting tree after rebalancing (if necessary)



Exercise

Consider the following 2-4 tree:

1. Insert 2 into the following 2-4 tree and show the resulting tree beside it.



2. Delete 12 from the following 2-4 tree and show the resulting tree beside it.