



Solution

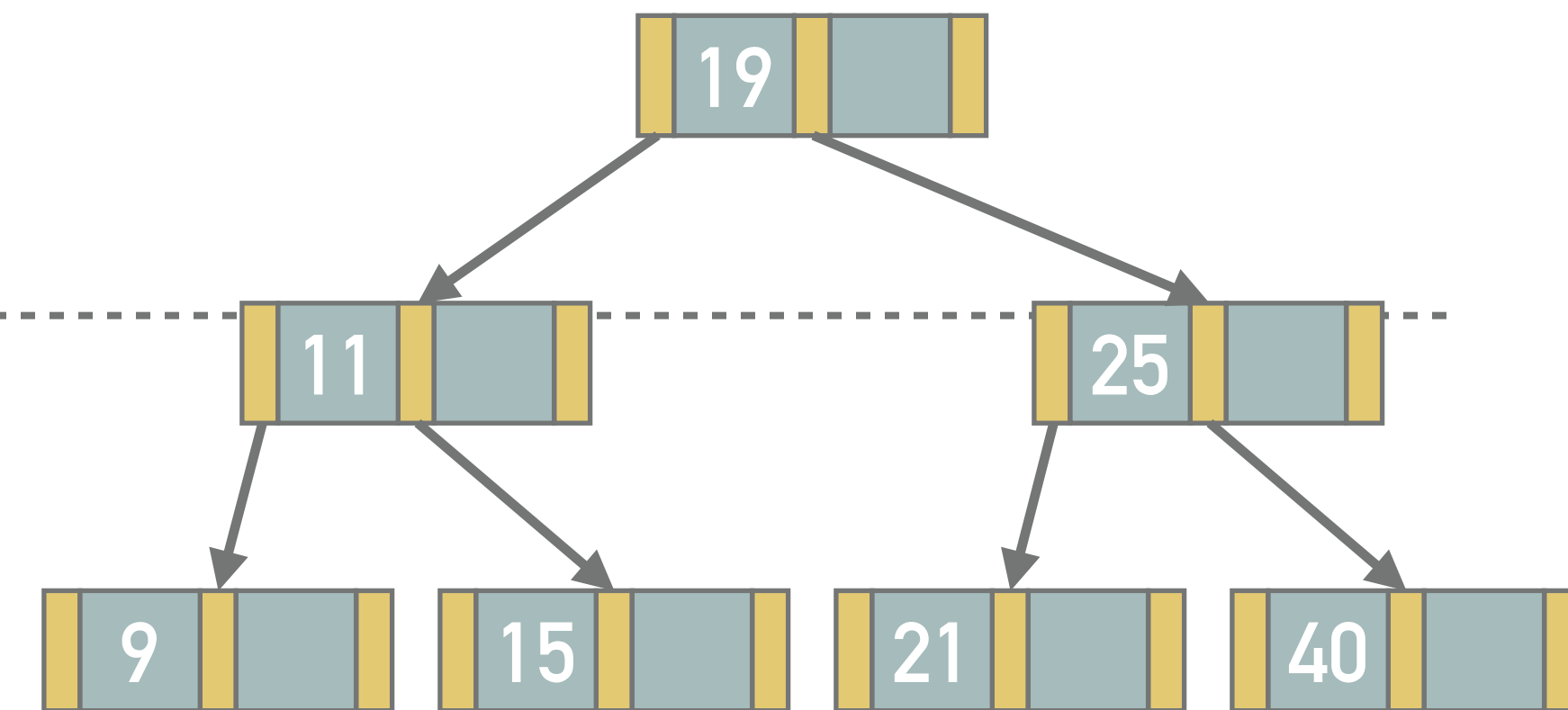
NDBI007: Practical class 5



Exercise 5.6 (Solution)

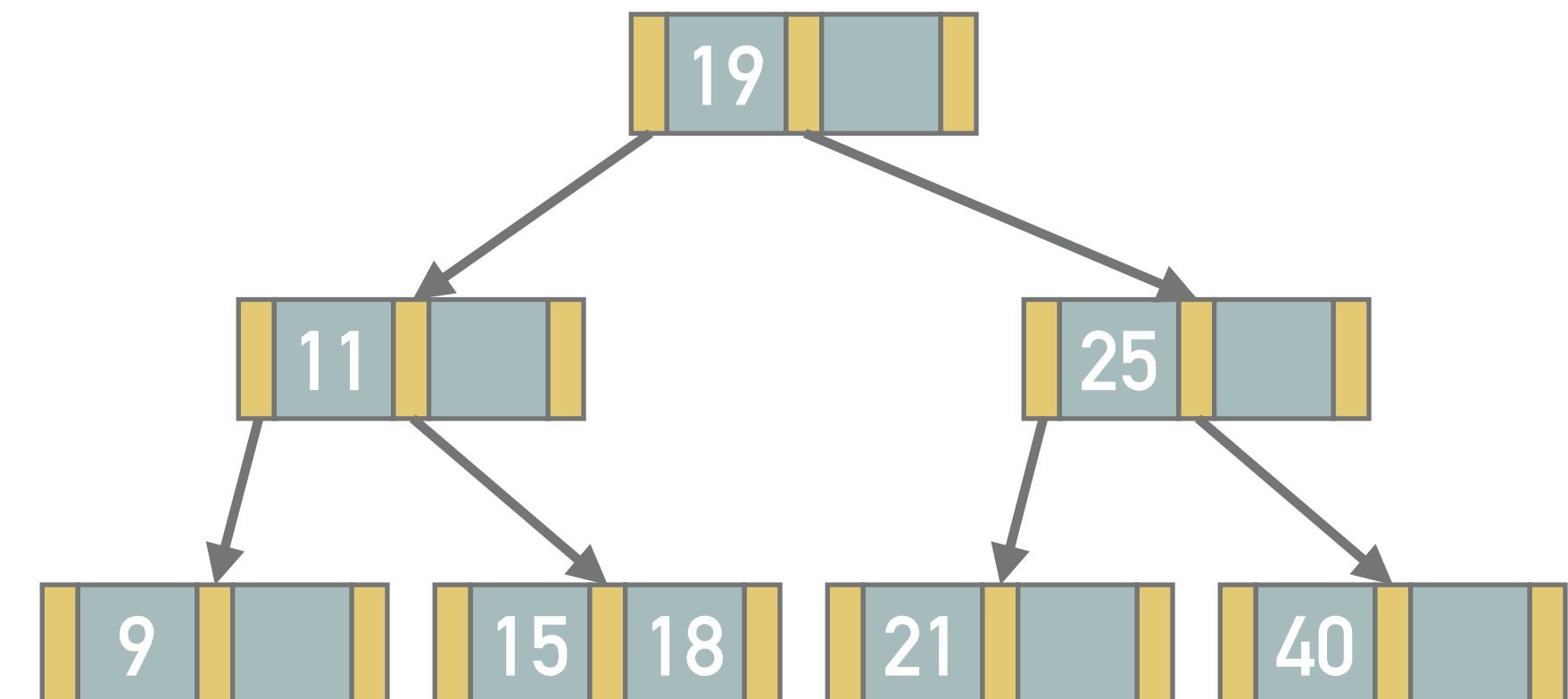
❖ Insertion of key 11

- ❖ Key 11 is less than 19, i.e., we navigate to the left (leaf) node (9, 15)
- ❖ After an attempt to insertion, the leaf (9, 11, 15) contains too many keys, a splitting occurs
- ❖ Key 11 goes to the parent (11, 19, 25) that also contains too many keys, i.e., additional splitting occurs and the tree height is increased



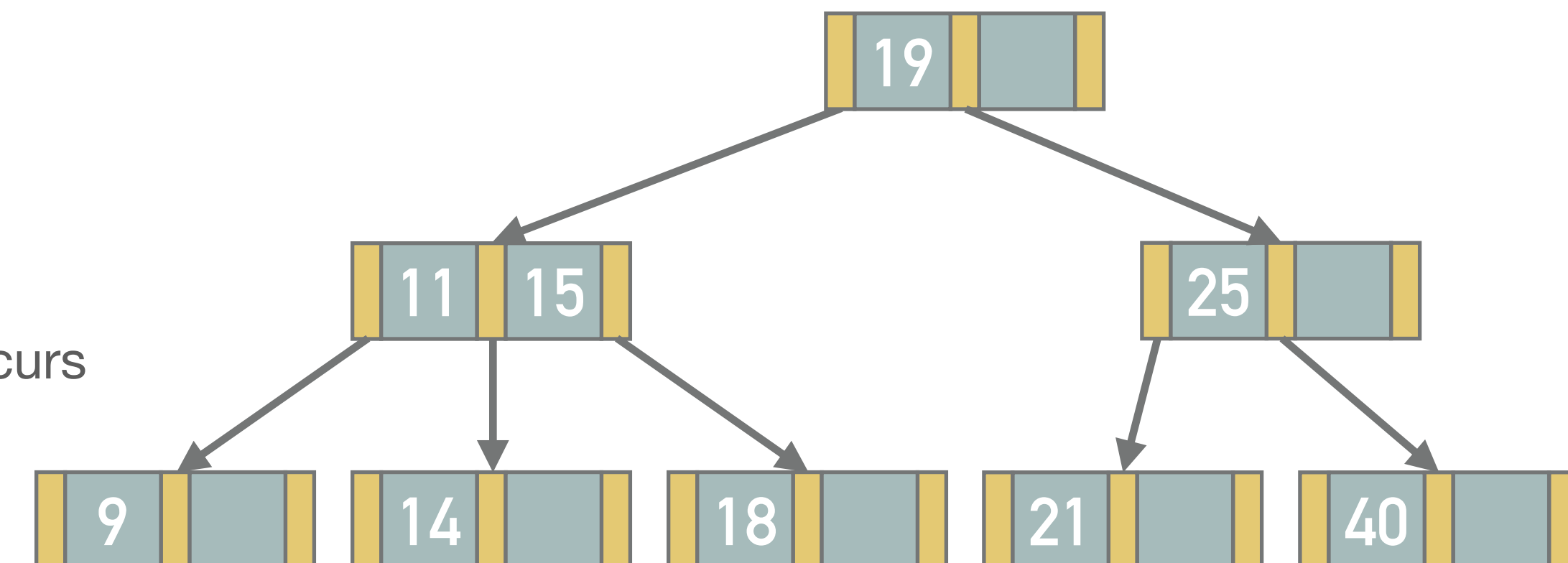
❖ Insertion of key 18

- ❖ Key 18 is less than 19, i.e., we navigate to the left node (11)
- ❖ Key 18 is greater than 11, i.e., we navigate to the right node (15)
- ❖ Key 18 goes to the leaf (15, 18)



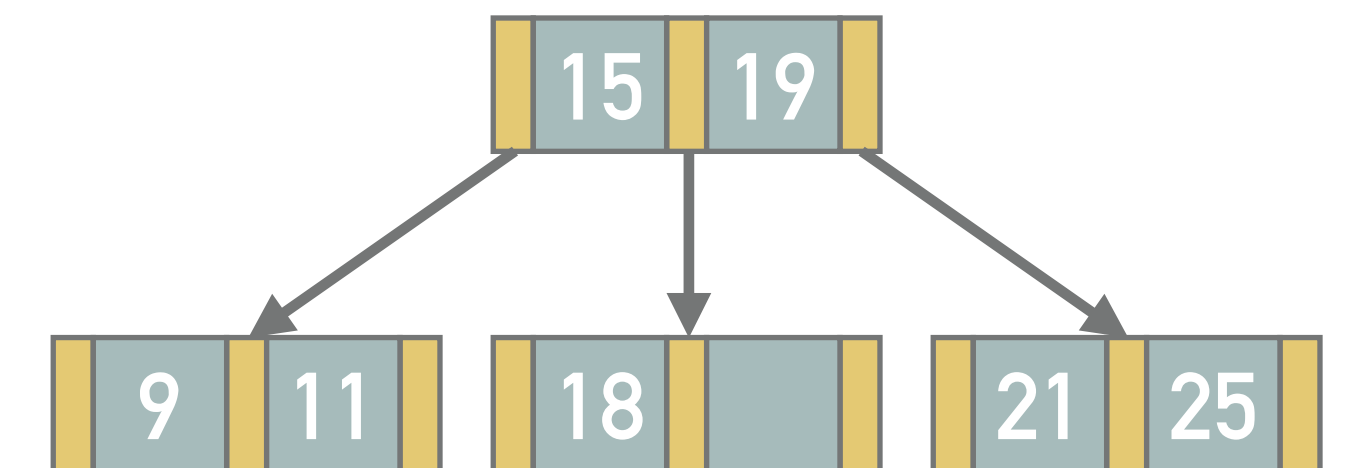
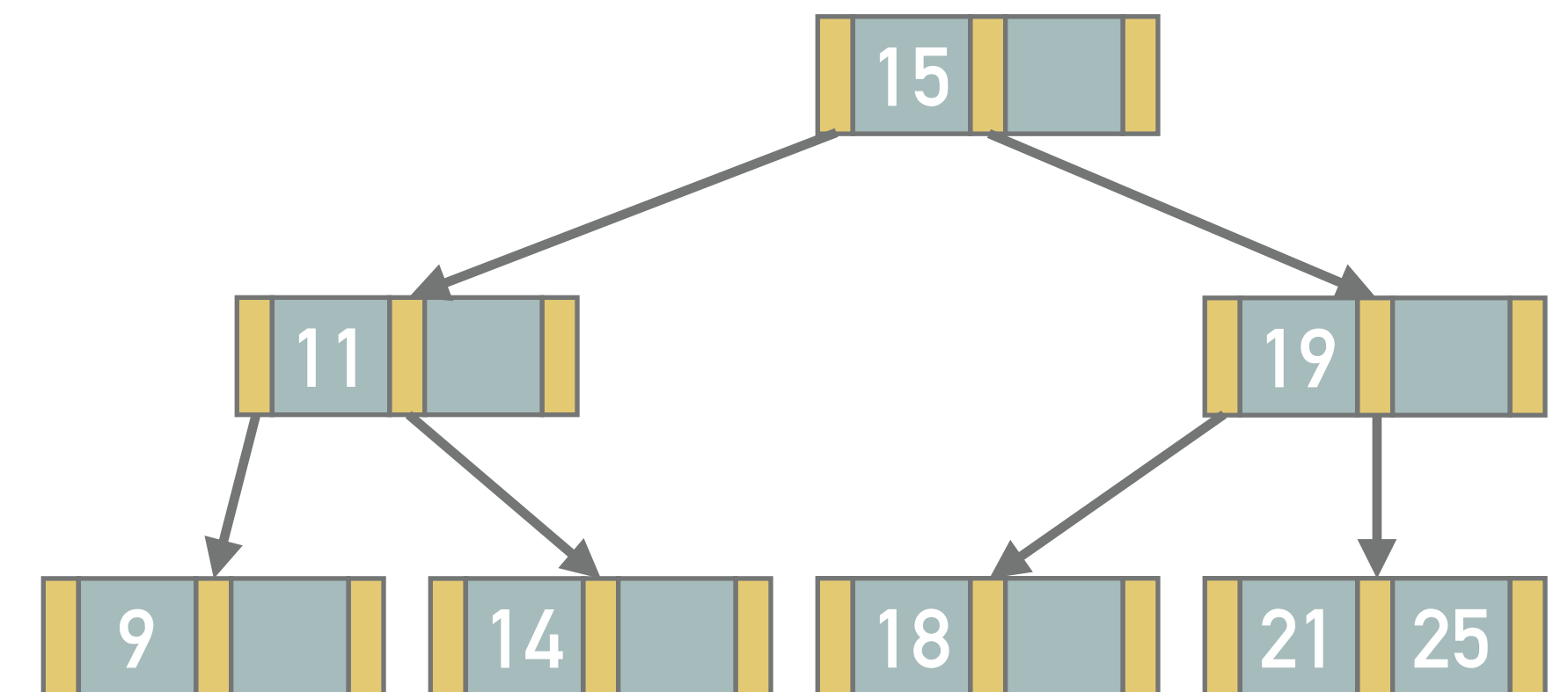
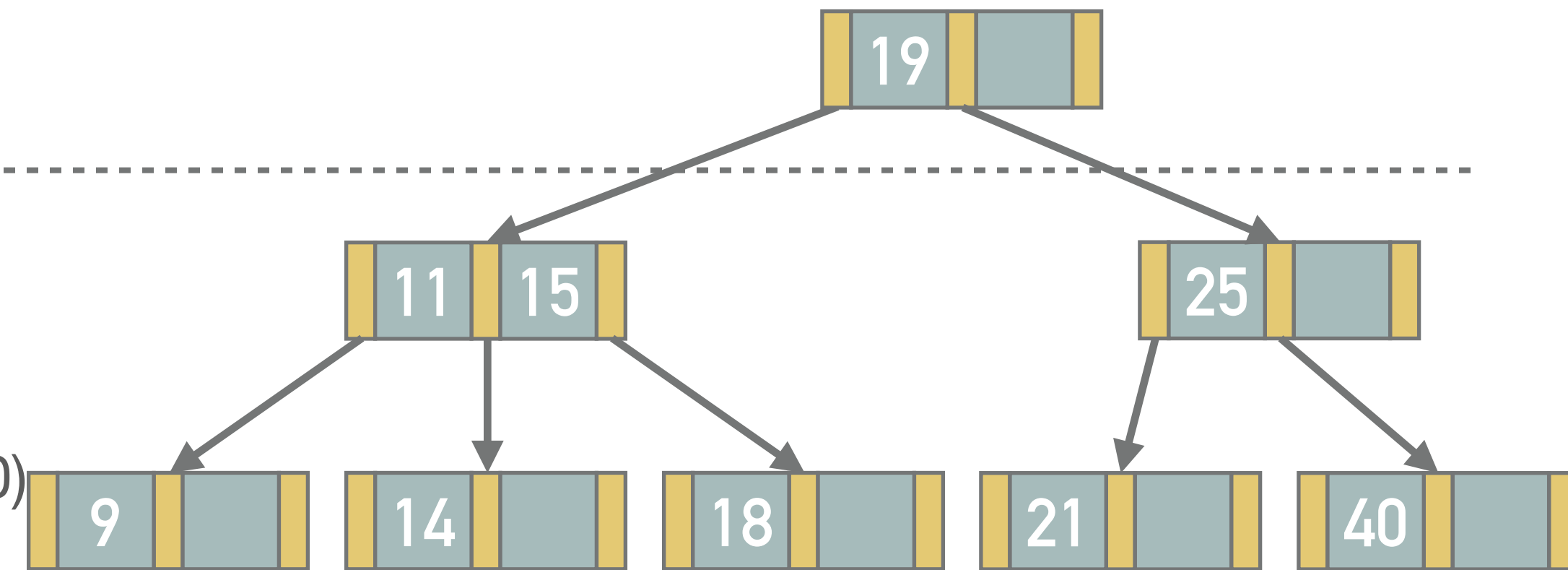
❖ Insertion of 14

- ❖ Key 14 is less than 19, i.e., we navigate to the left node (11)
- ❖ Key 14 is greater than 11, i.e., we navigate to the right (leaf) node (15, 18)
- ❖ After the insertion, the leaf (14, 15, 18) contains too many keys, a splitting occurs
- ❖ Key 15 goes to the parent node (11, 15)



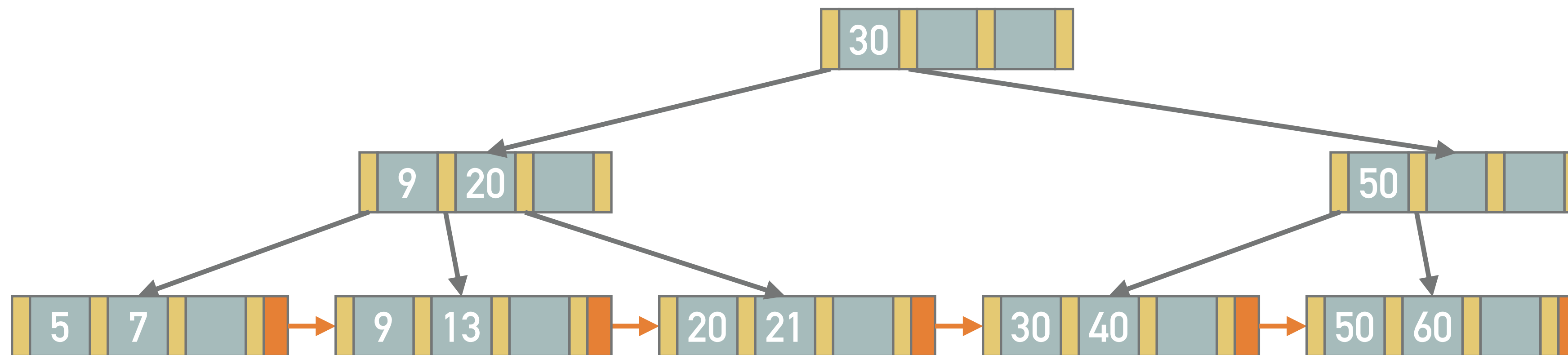
Exercise 5.6 (Solution Continued)

- ❖ Deletion of record with key 40
 - ❖ Key 40 is greater than 19, i.e., we navigate to the right node (25)
 - ❖ Key 40 is greater than 25, i.e., we navigate to the right (leaf) node (40)
 - ❖ Key 40 is removed, but we have to merge nodes (empty) and (25)
 - ❖ Parent node (empty) has too few keys, therefore we take key from the left sibling (19)
 - ❖ Finally, taking a key from the left children (11, 15), 15 goes to the root node
- ❖ Deletion of record with key 14
 - ❖ Key 14 is less than 15, i.e., we navigate to the left node (11)
 - ❖ Key 14 is greater than 11, i.e., we navigate to the right (leaf) node (14)
 - ❖ Key 14 is removed, causing the splitting of nodes (9) and (11)
 - ❖ Finally, we have to merge nodes (15, 19) to establish a new root node



Exercise 5.12 (Solution)

- ❖ The insertion of a record with key 40 splits the right leaf node into nodes (20, 21) and (30, 40)
 - ❖ The separating value 30 is inserted into the parent node where there is enough space
- ❖ The insertion of a key 50 is trivial, it goes to the node (30, 40, 50)
- ❖ The insertion of a key 60 splits the right leaf node into nodes (30, 40) and (50, 60)
 - ❖ The separating value 50 is inserted into the parent node (9, 20, 30, 50) where it leads to the cascade split
 - ❖ The parent is split to nodes (9, 20) and (50) while (30) goes to the root node



Exercise 5.17 (Solution)

- ❖ We can delete the record 15 while moving the record 20 to the neighboring node and modification of the split value
- ❖ The record with key 9 will be removed while moving the record with key 8 and modification of the split value
- ❖ The record with key 8 will be removed while moving the record with key 7 and modification of the split value
- ❖ Removing another record would lead to merging of the tree nodes into two

