DATA STRUCTURE AND ALGORITHM
HW07
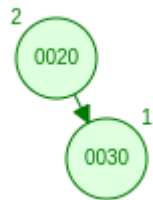## PART 01

MOHAMMAD ASHRAF YAWAR
161044123

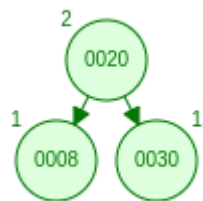# Q1:
- AVL Tree:

20, 30, 8, 47, 39, 18, 41,23

BUILDING AVL TREE:
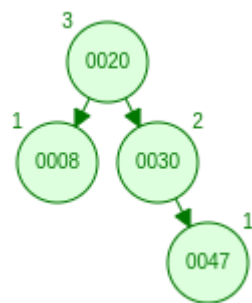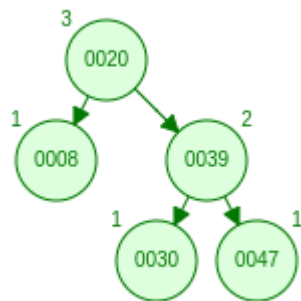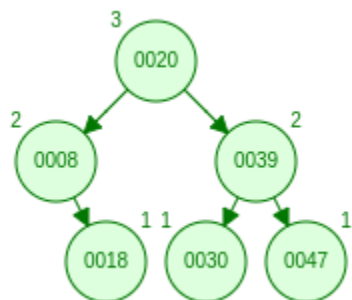
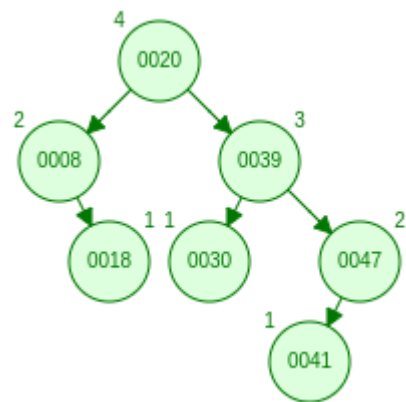INSERTING 20 ..

INSERTING 30 ..

INSERTING 8 ..

INSERTING 47 ..

3
0020
1
0008
2
0030
1
0047

INSERTING 39 ..

3
0020
1
0008
2
0039
1
0030
1
0047

INSERTING 18 ..

3
0020
2
0008
2
0039
1
0018
1
0030
1
0047
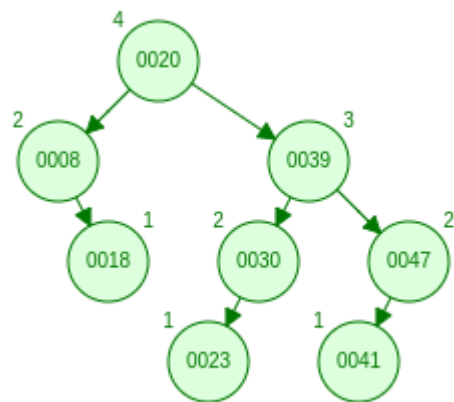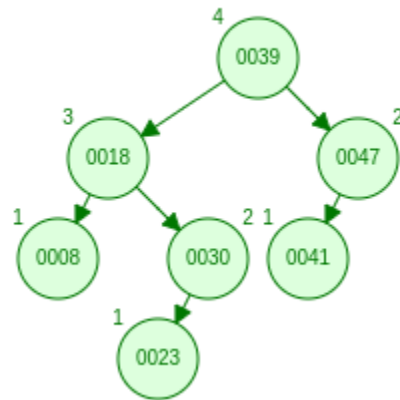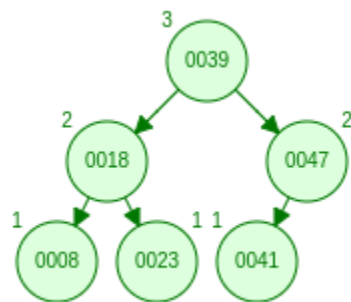
INSERTING 41 ..

INSERTING 23 ..

REMOVING PROCESS :
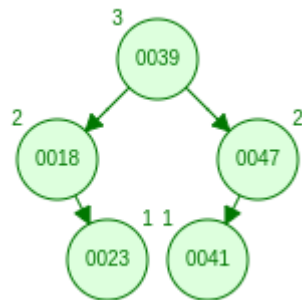
REMOVING 20 …
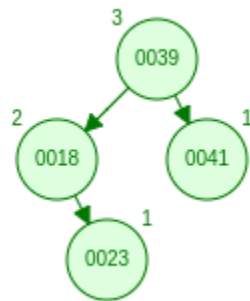

REMOVING 30 …

REMOVING 8 …

REMOVING 47 …

REMOVING 39 …

REMOVING 18 …

REMOVING 41 …

REMOVING 23 …

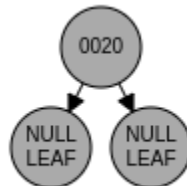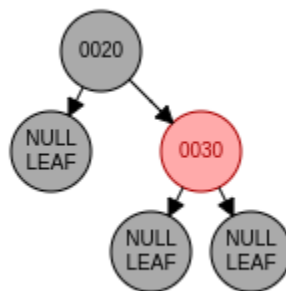ALL DELETED !!!!

- Red-Black Tree:
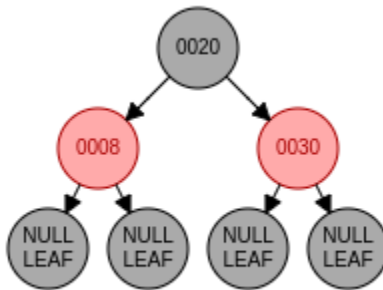# 20, 30, 8, 47, 39, 18, 41,23

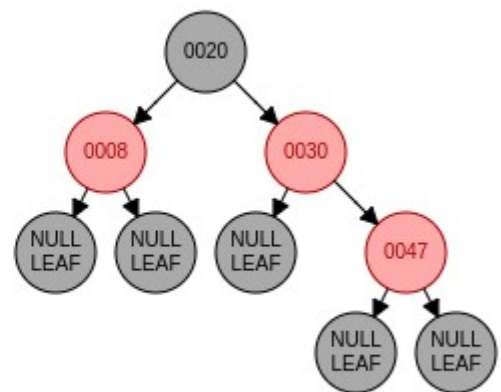BUILDING RED-BLACK TREE:
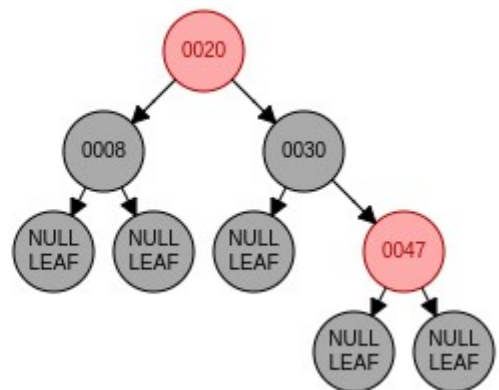
INSERTING 20 …

INSERTING 30 …

INSERTING 08 …

INSERTING 47 …

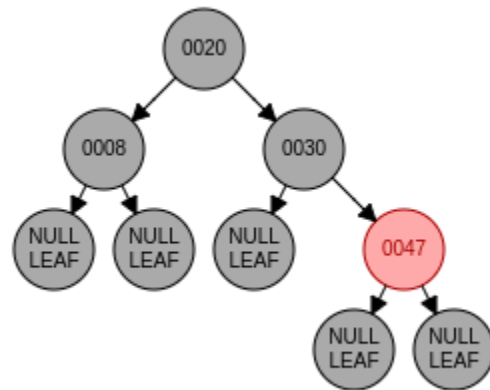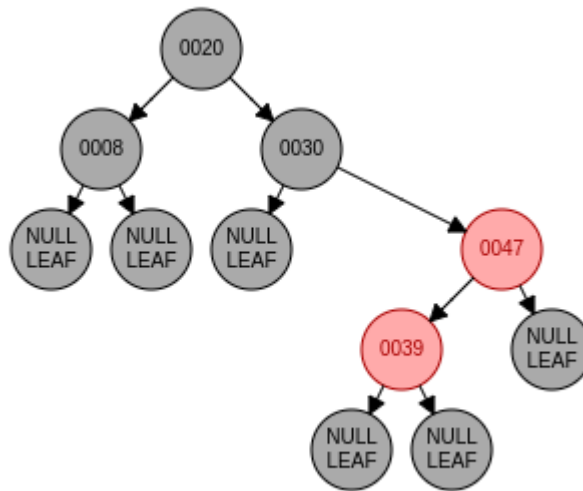Found null tree (or phantom leaf), inserting element

Root of the tree is red. Color it black

INSERTING 39 …
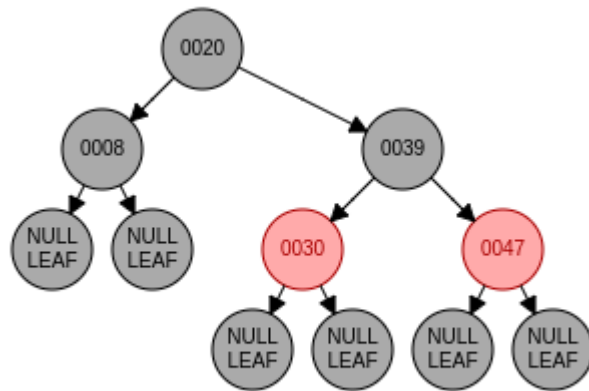
INSERTING 18 …

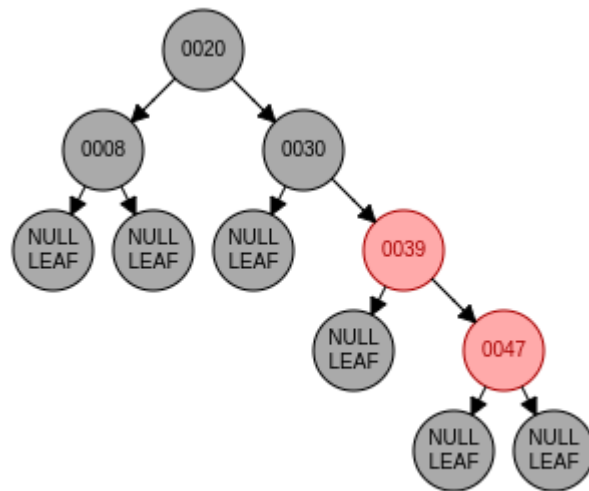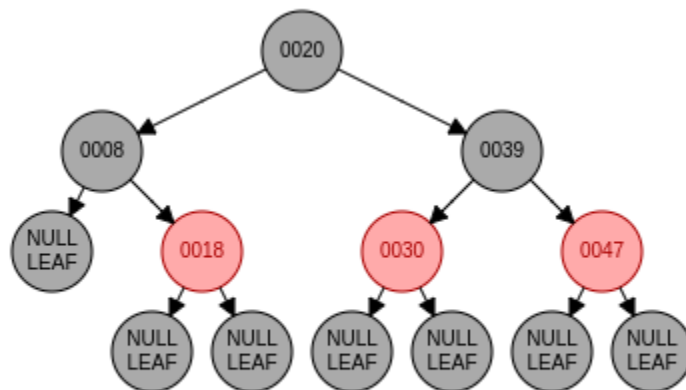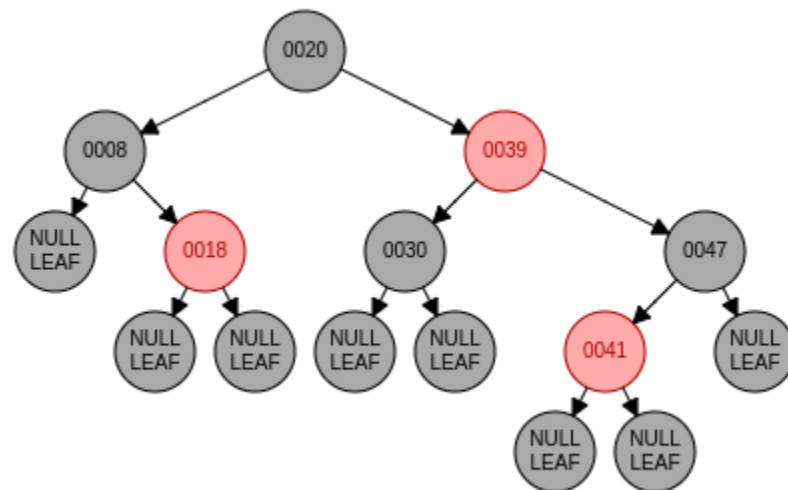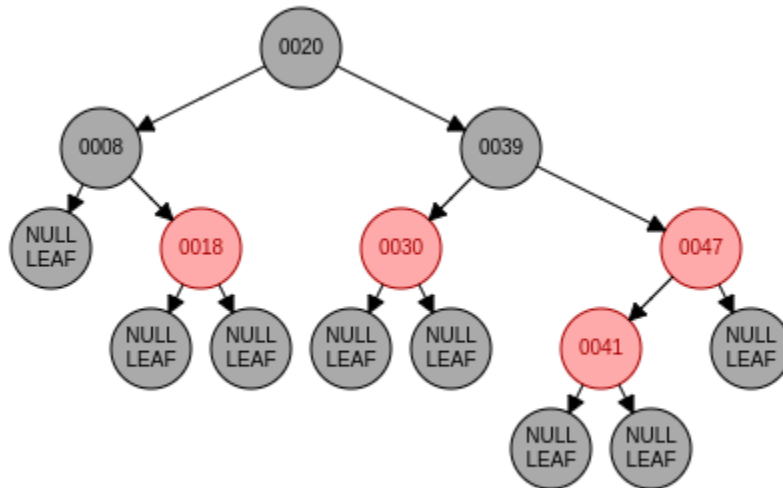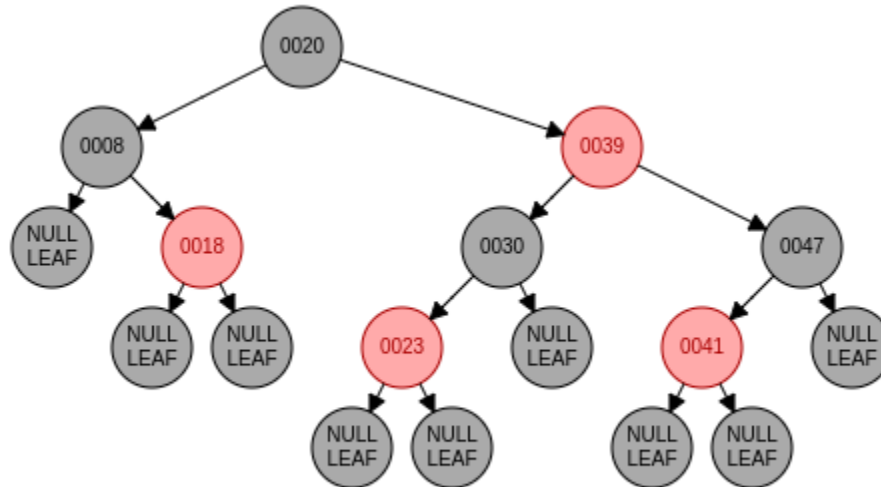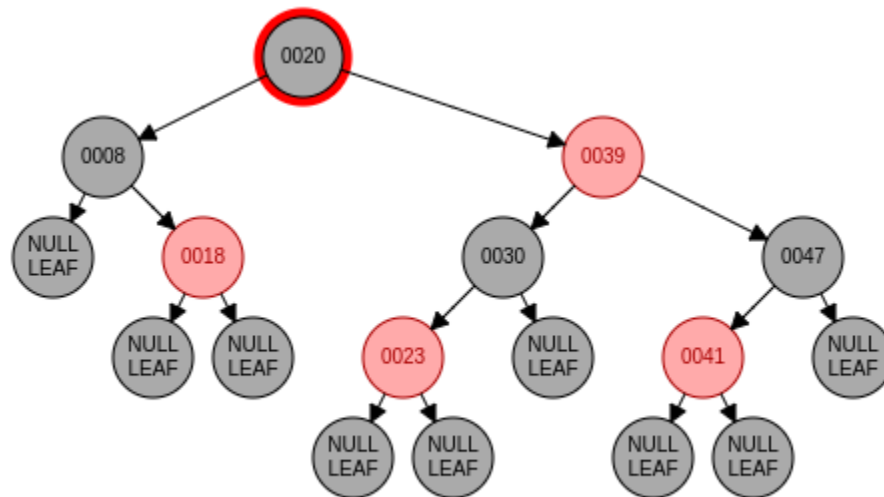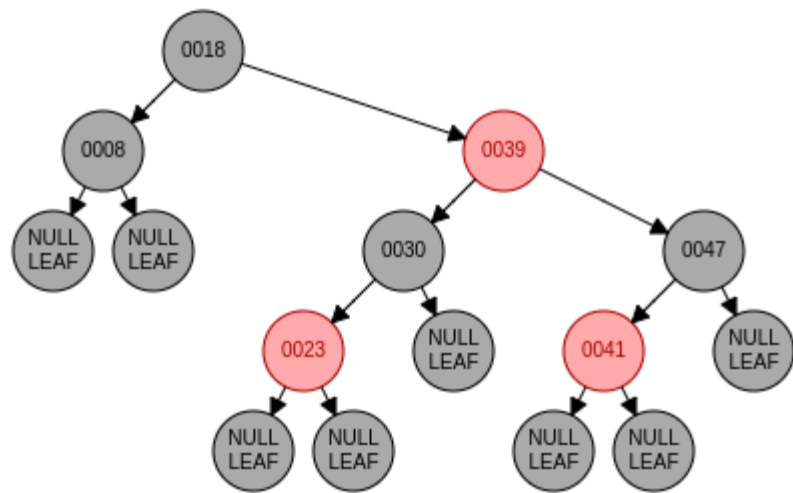INSERTING 41 …

INSERTING 23 …

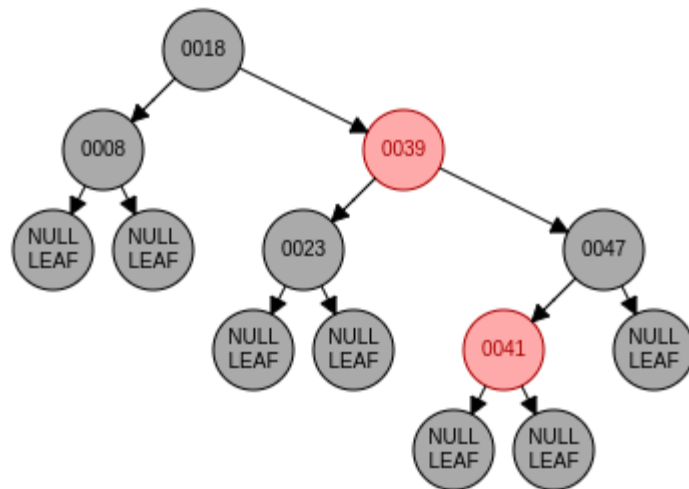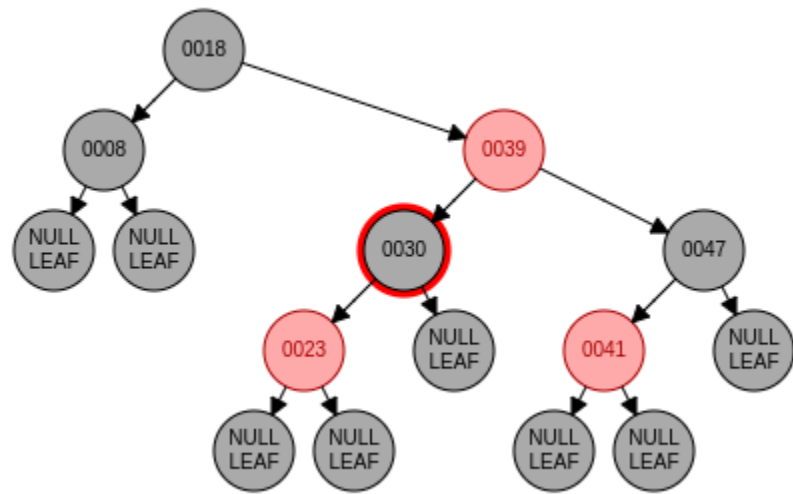DELETING IN FIFO MODE:

DELETING 20 …

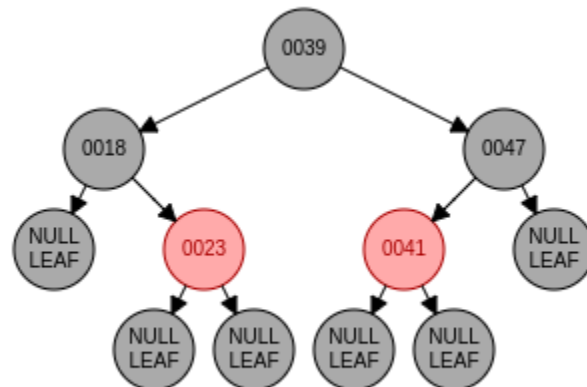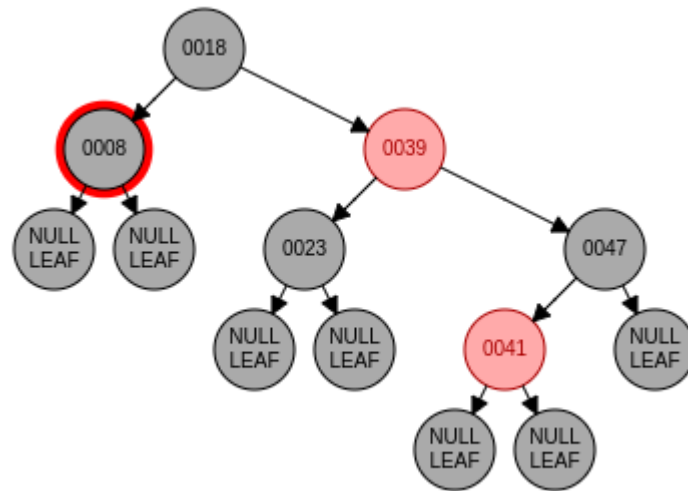DELETING 30 …
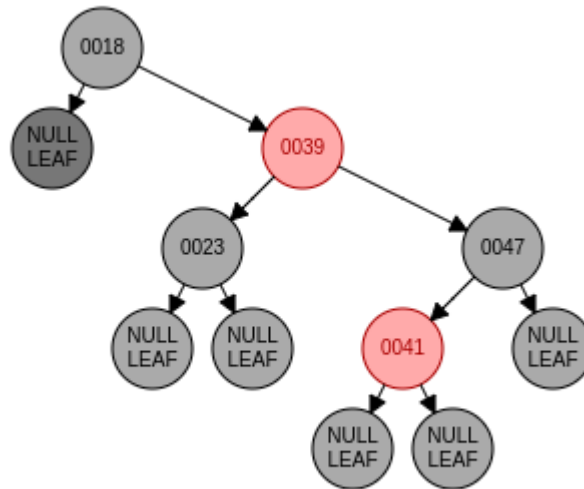
DELETING 8 …

DELETING 47 …

DELETING 39 …

DELETING 18 …

Double black node has black sibling and 2 black nephews. Push up black level

DELETING 41 …
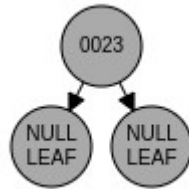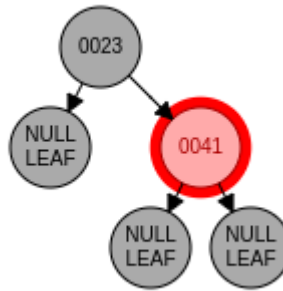
DELETING 23 …

ALL DELETED !!!!

- 2-3 Tree:
20, 30, 8, 47, 39, 18, 41,23

BUILDING 2-3 TREE:

INSERTING 20 …

INSERTING 30 …

INSERTING 8 …

8   20   30

20

8   30

INSERTING 47 …

20

8   30   47

INSERTING 39 …

20   39

8   30   47

INSERTING 18 …

20   39

8   18   30   47

INSERTING 41 …

20   39
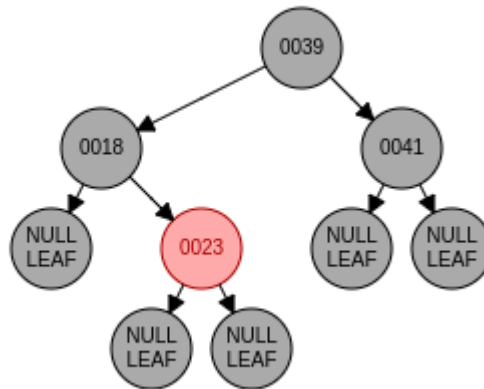
8   18   30   41   47

INSERTING 23 …

DELETING FROM 2-3 TREE:

DELETING 20 …
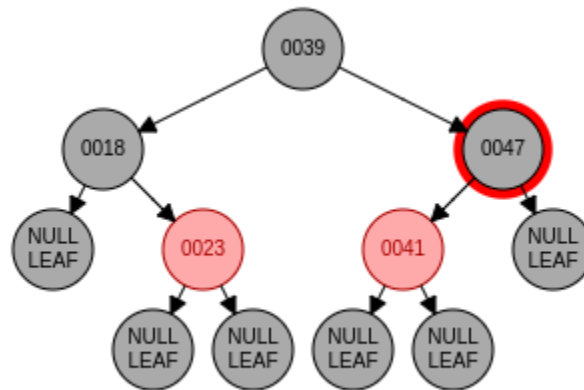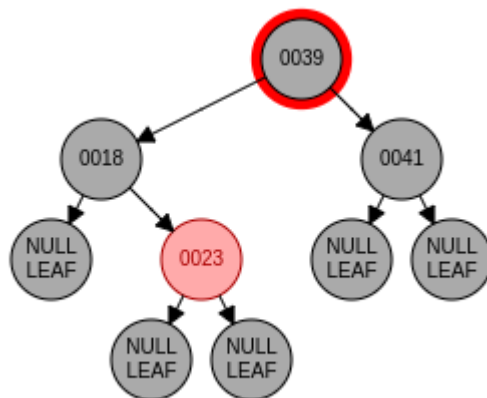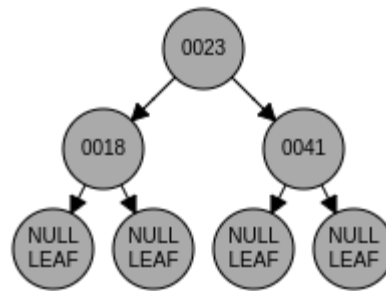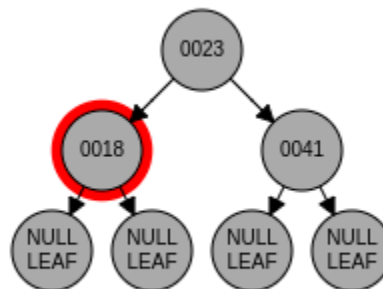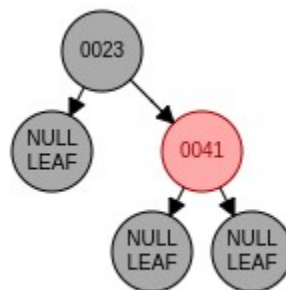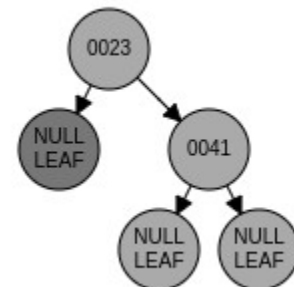

DELETING 30 …

DELETING 8 …
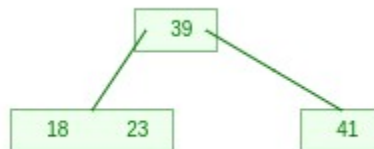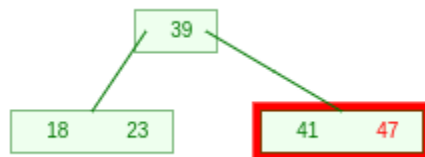
DELETING 47 …
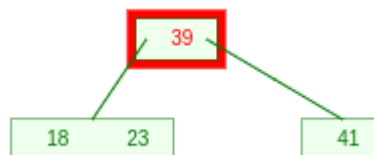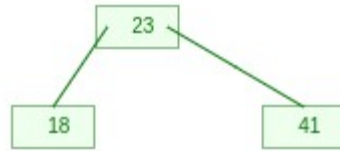
DELETING 39 …
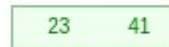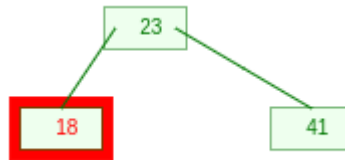
DELETING 18 …

DELETING 41 …
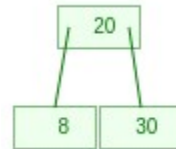

DELETING 23 …

all deleted !!!

Skip List :
20, 30, 8, 47, 39, 18, 41,23

BUILDING Skip List:

since we have 8 elements we can satisfy with list level of at most m = 4.

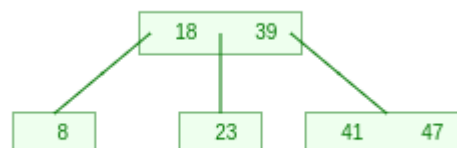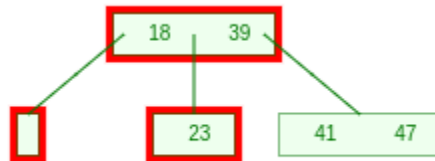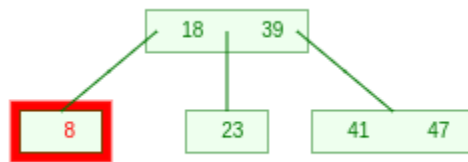so in each adding or insertion process we generate number between one and 4 (including both) to determine the level of that particular element.

INSERTING 20 …

random generator = 4

Key to right > target; moving down.
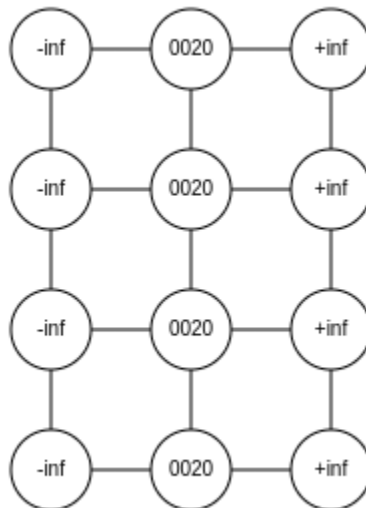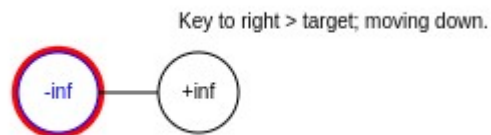
INSERTING 30 …
random generator = 1

Key to right <= target; moving right.

Key to right > target; moving down.
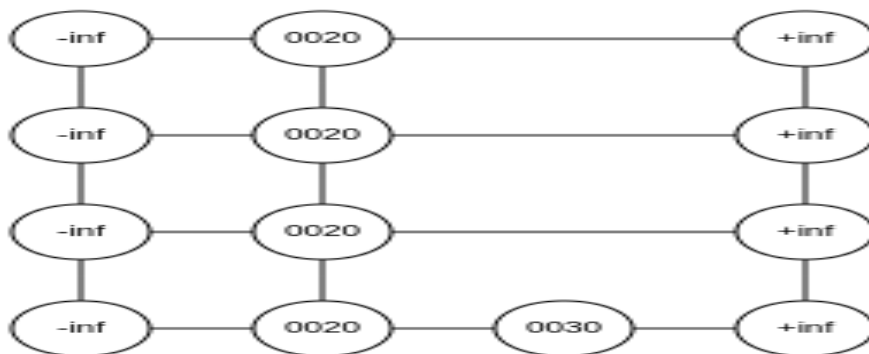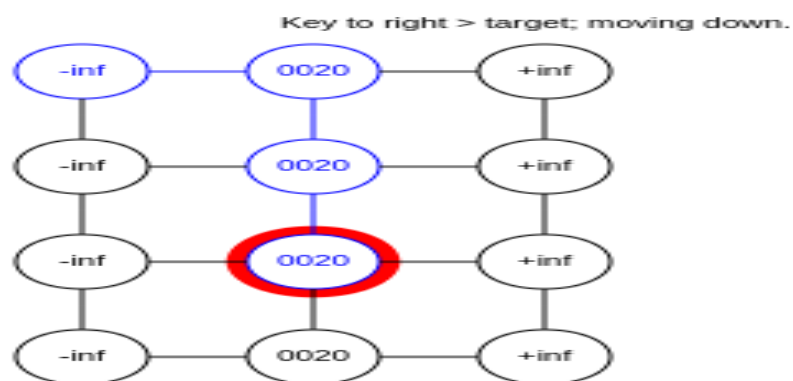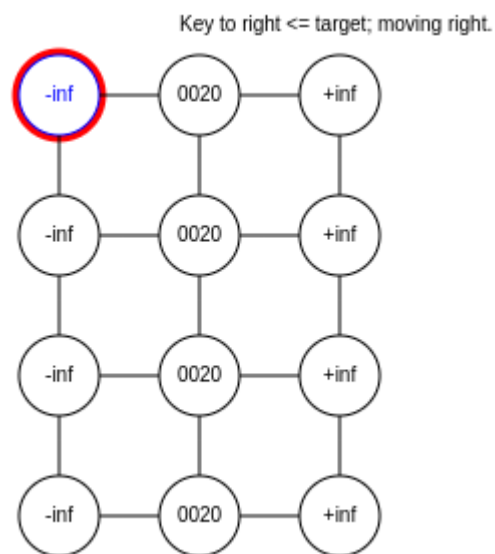
INSERTING 8 …
random generator = 1

Key to right > target; moving down.
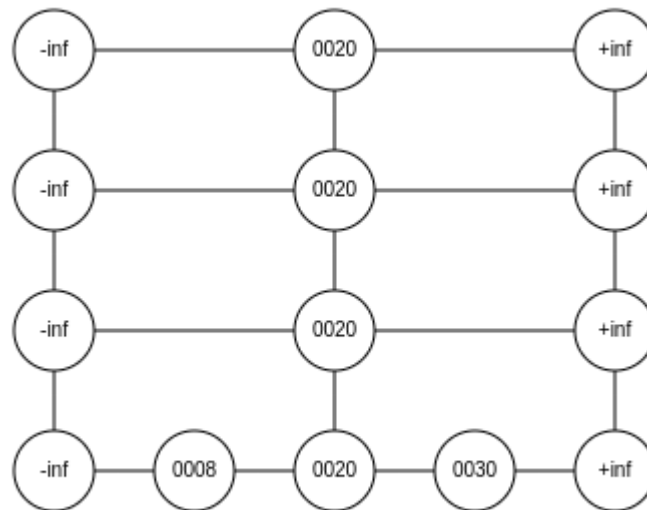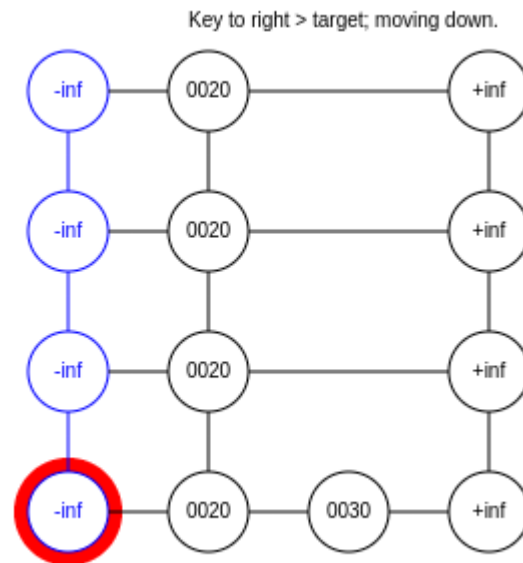
INSERTING 47 …
random generator = 1

Key to right > target; moving down.

INSERTING 39 …
random generator = 1

Key to right > target; moving down.

INSERTING 41 …
random generator = 1

Key to right > target; moving down.

Key to right > target; moving down.

INSERTING 23 …
random generator = 1

Key to right <= target; moving right.
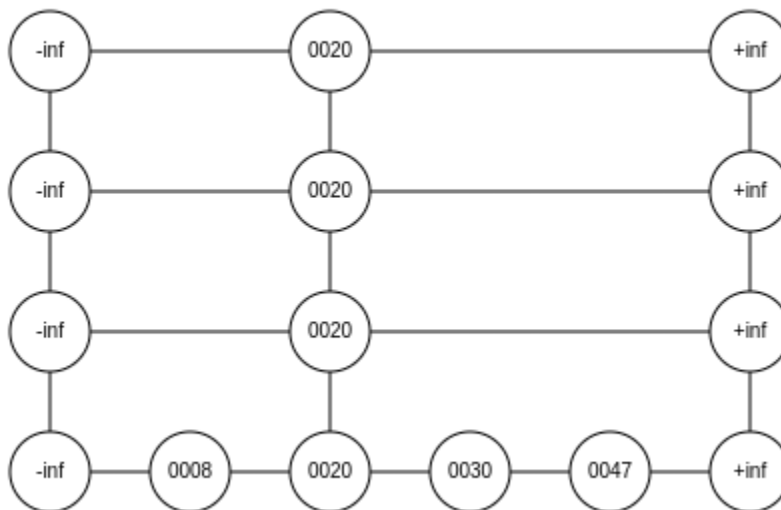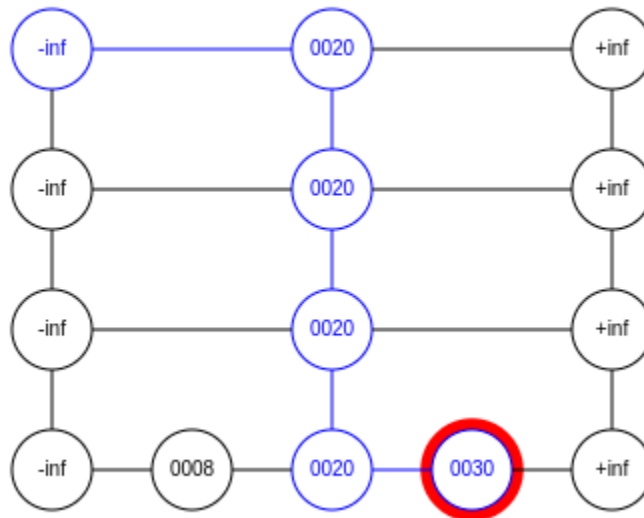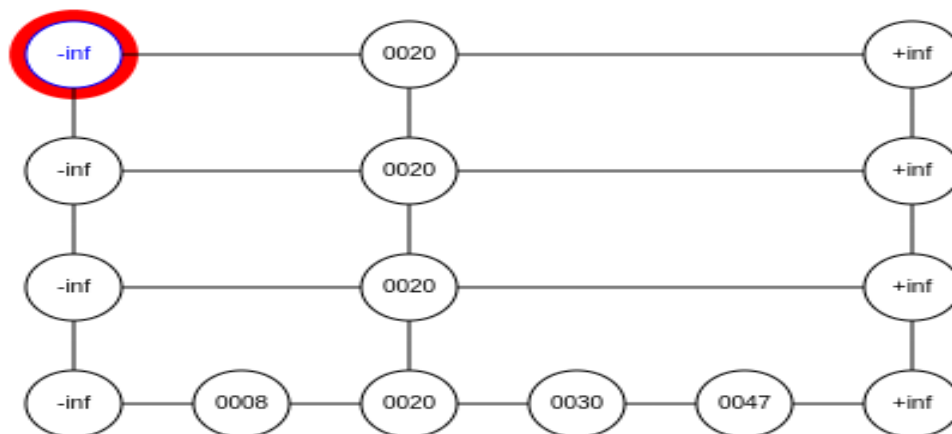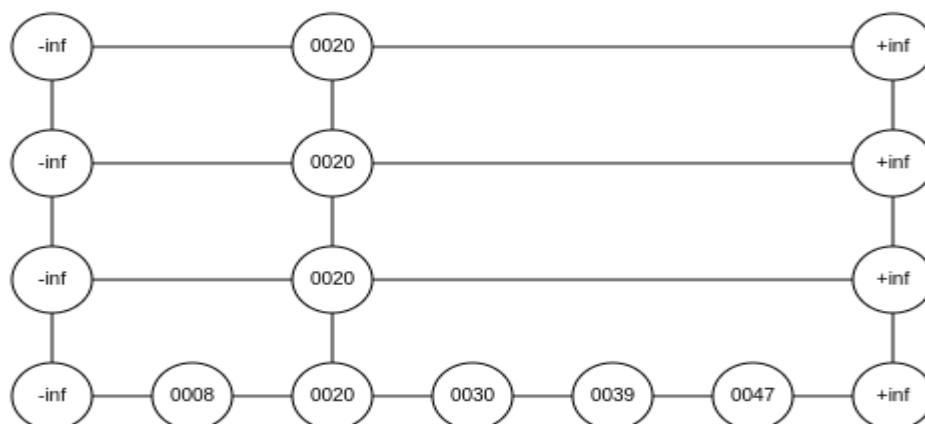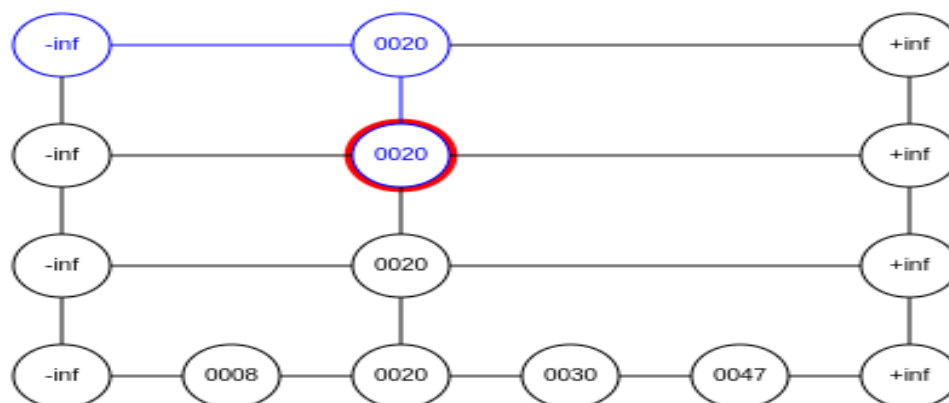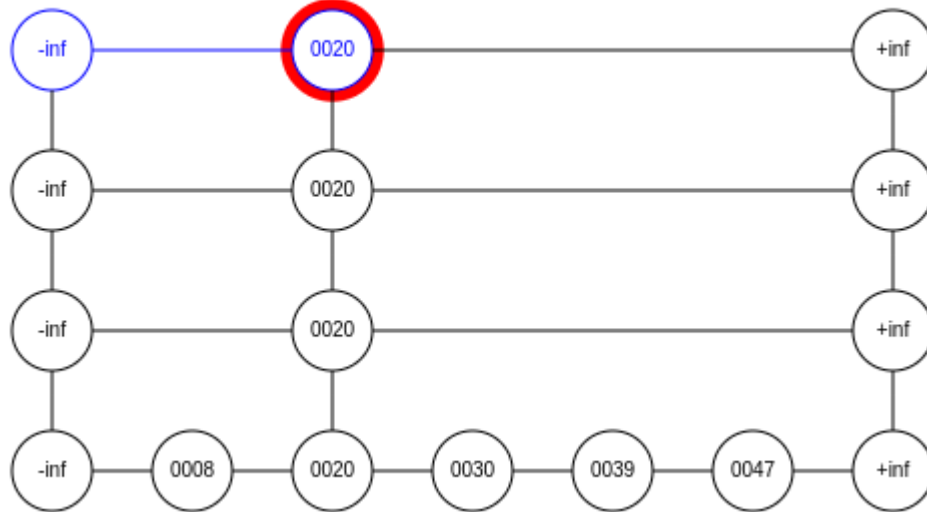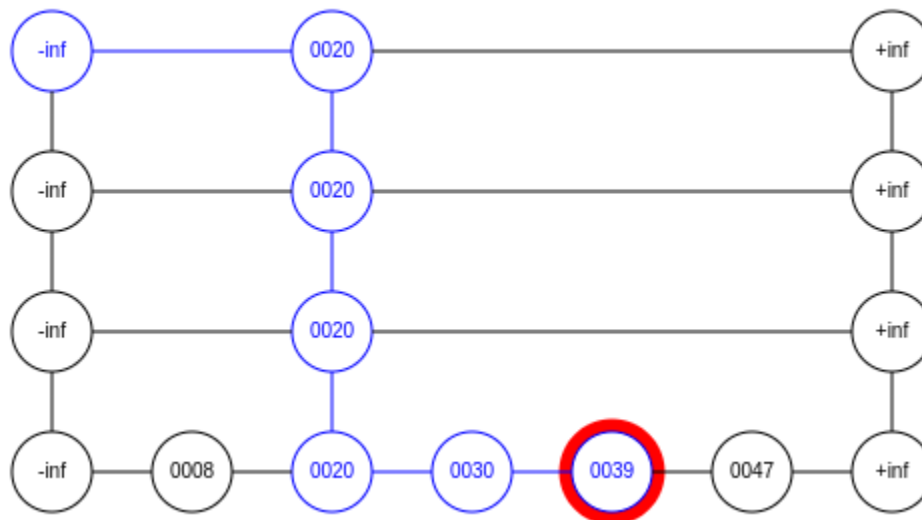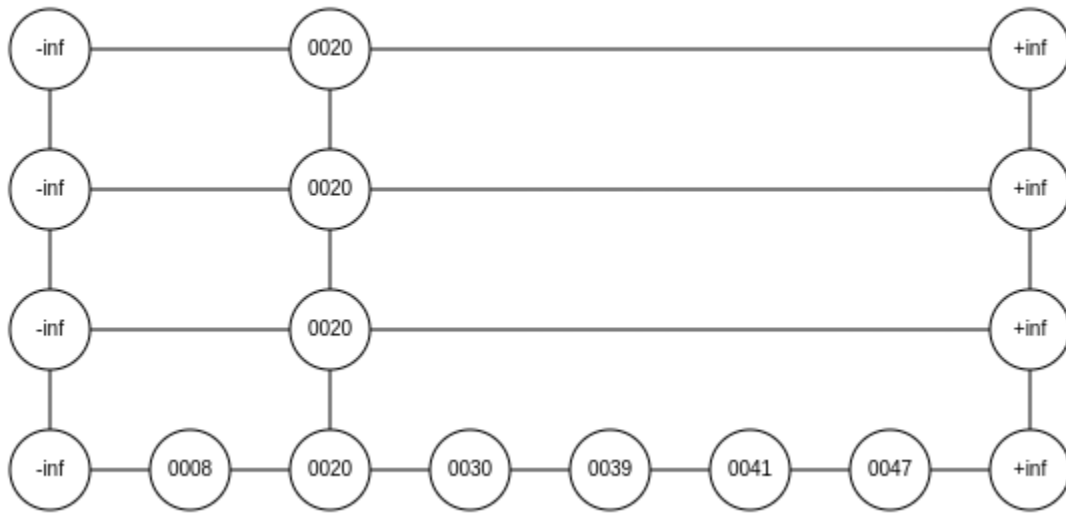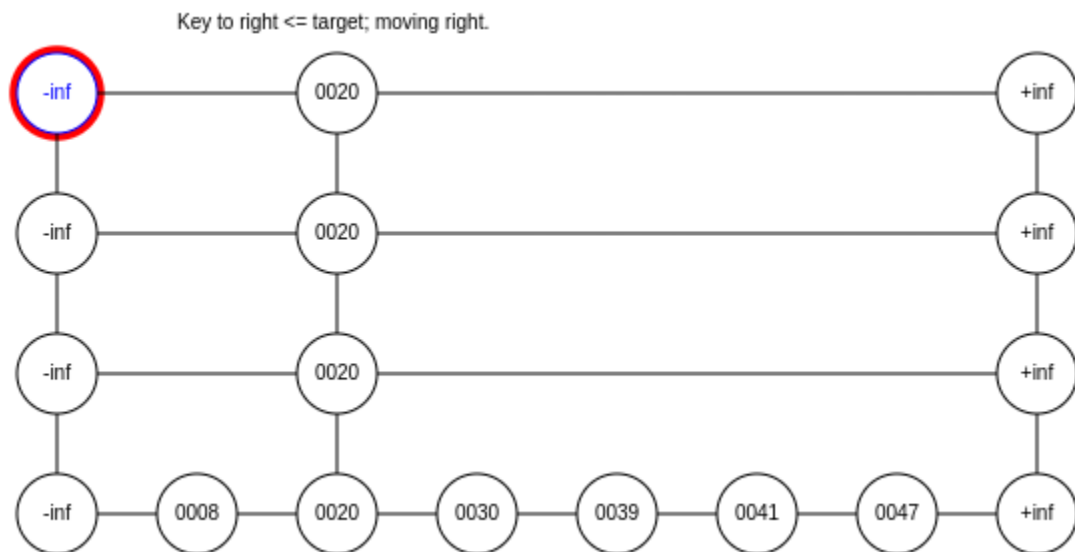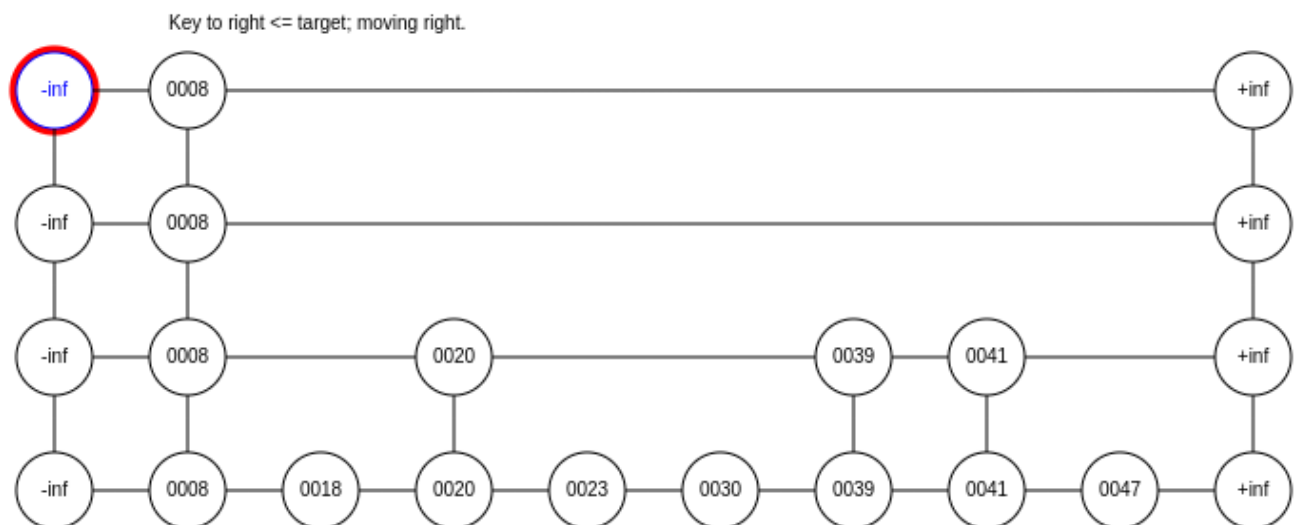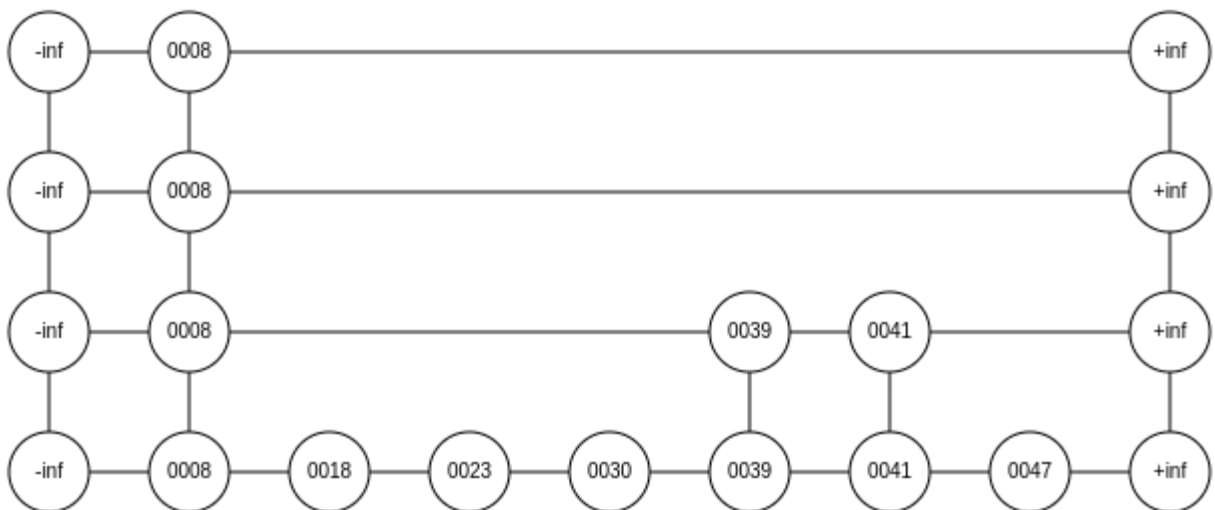
considering we have the bellow skiplist:
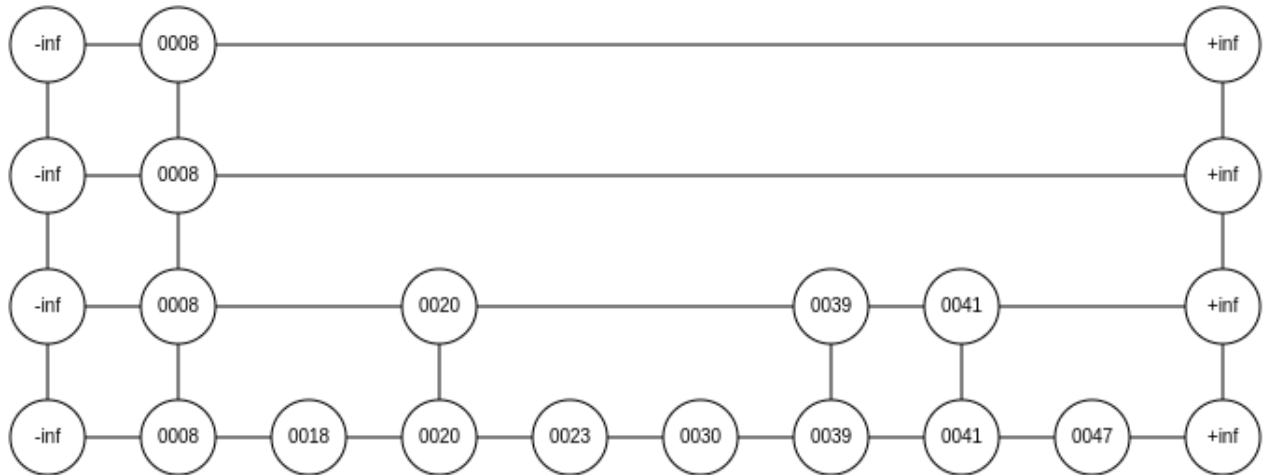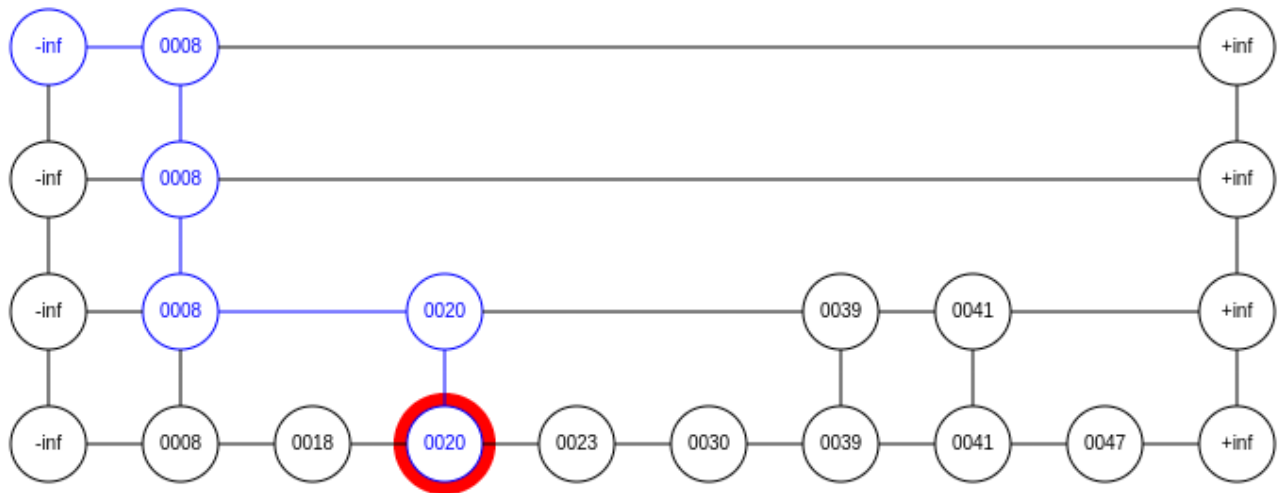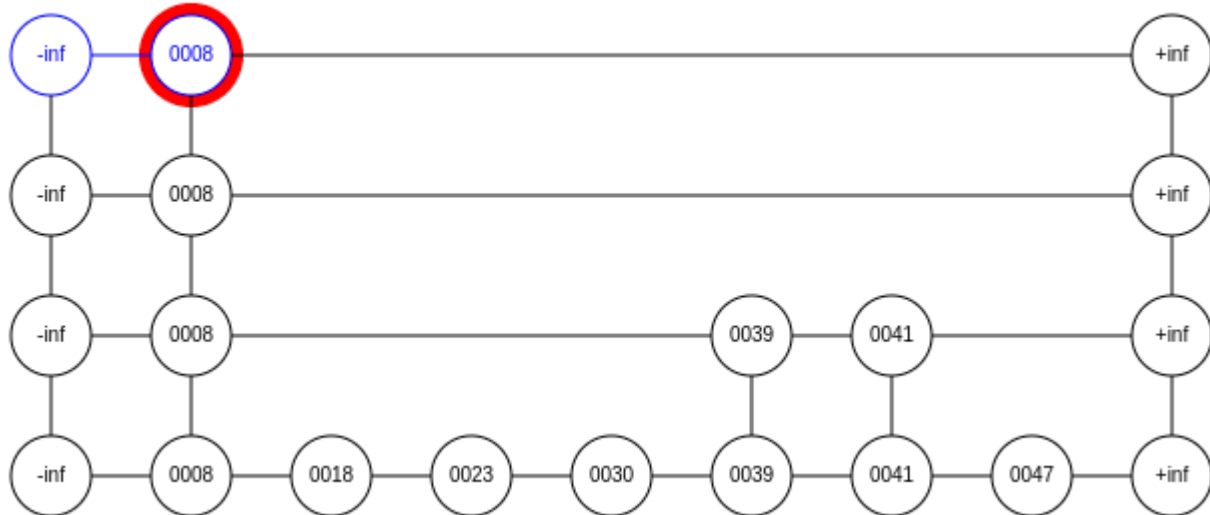

removing will have :

removing 20 …

Key to right > target; moving down.

removing 30…

Key to right > target; moving down.

-inf	0008								+inf
-inf	0008								+inf
-inf	0008				0039	0041			+inf
-inf	0008	0018	0023	0030	0039	0041	0047		+inf

Key to right <= target; moving right.

-inf	0008								+inf
-inf	0008								+inf
-inf	0008				0039	0041			+inf
-inf	0008	0018	0023	0030	0039	0041	0047		+inf
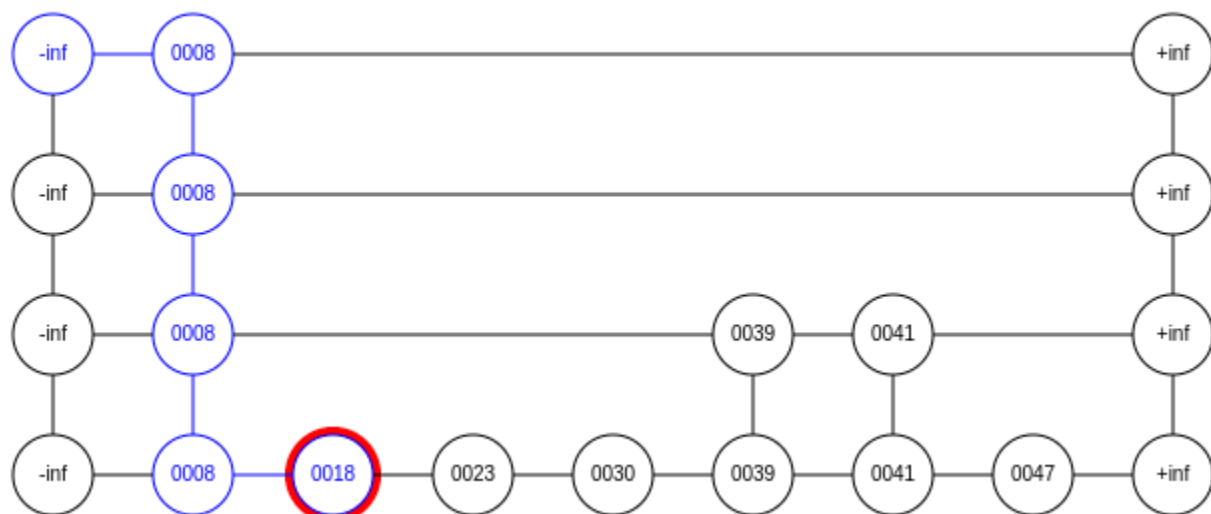
Can't move down; search finished.
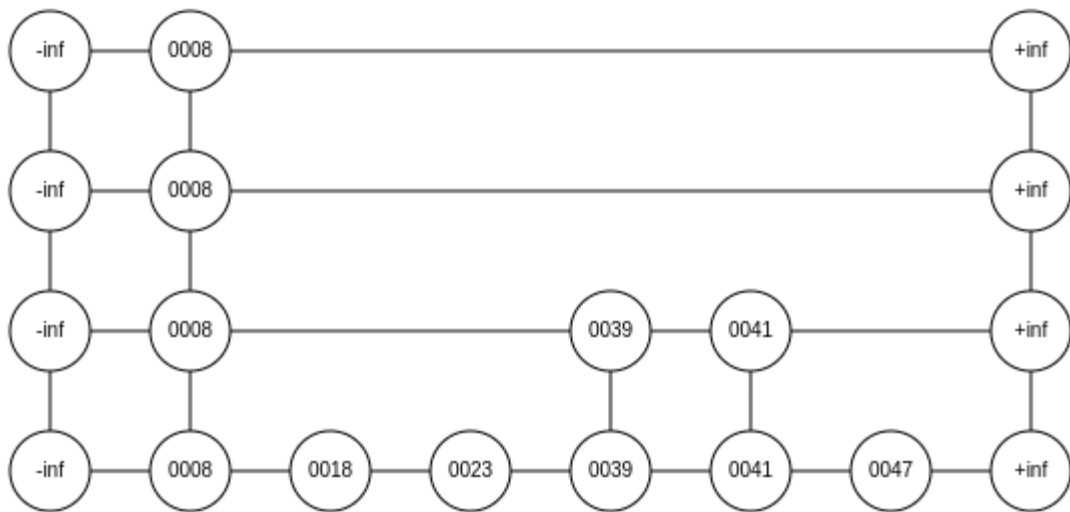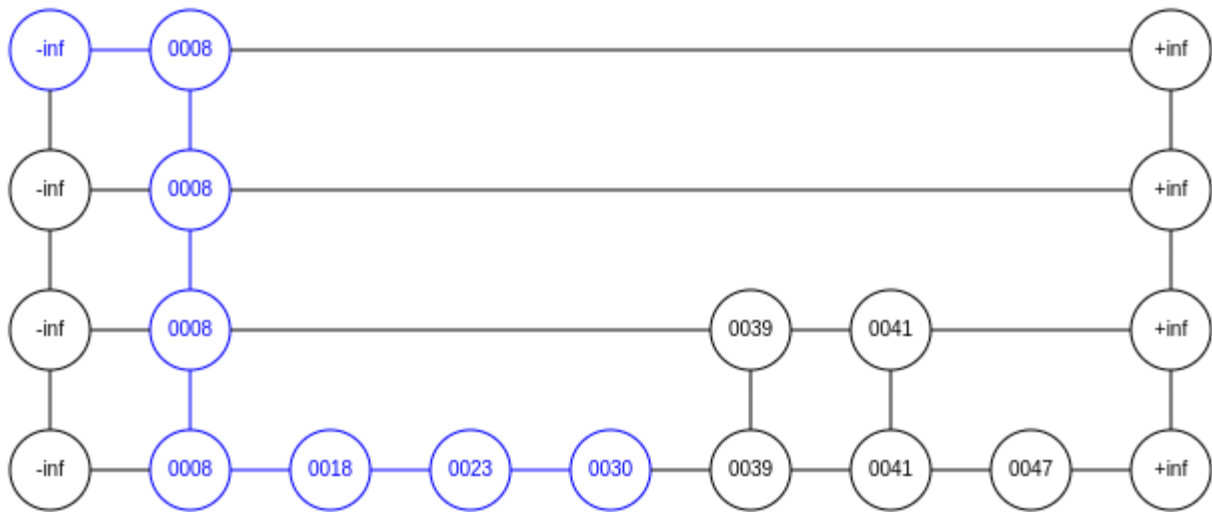
removing 8 …

Removing.
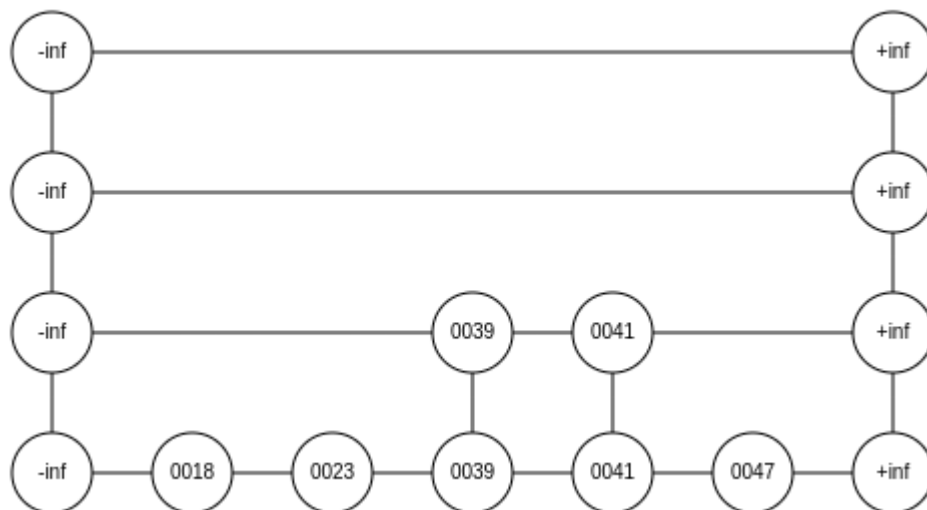
removing 47 …

Key to right > target; moving down.

removing 39…

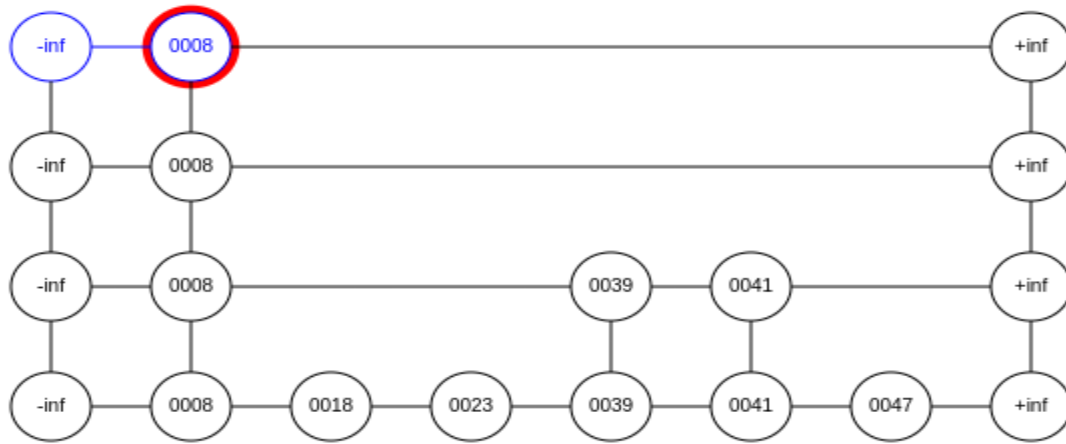removing 18…

Key to right > target; moving down.

-inf ——————————— +inf
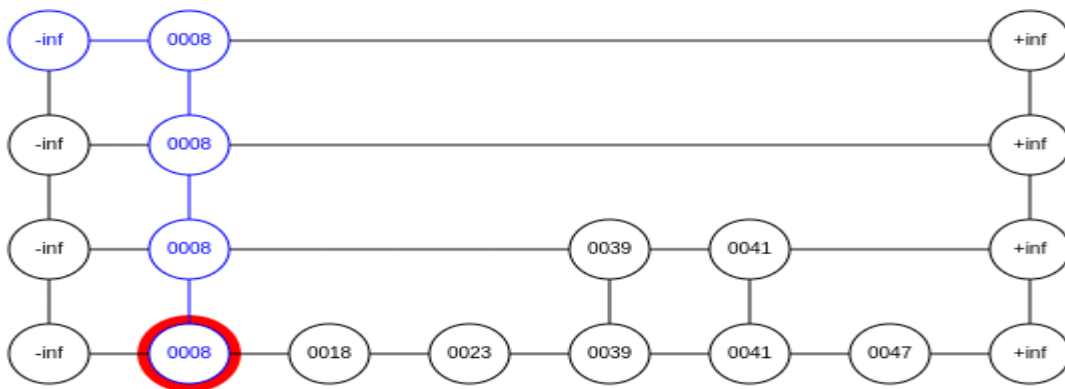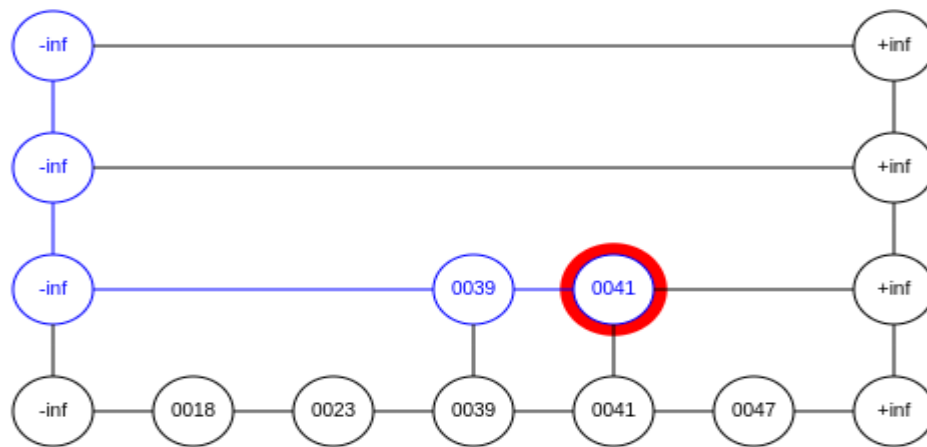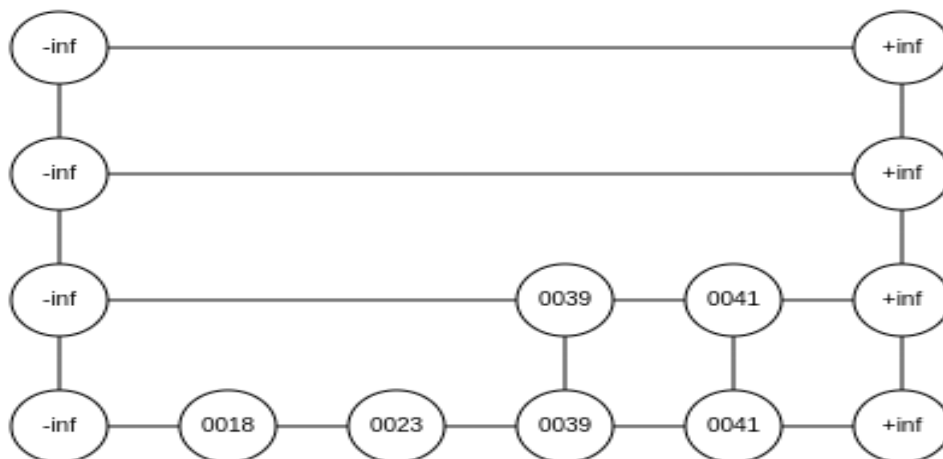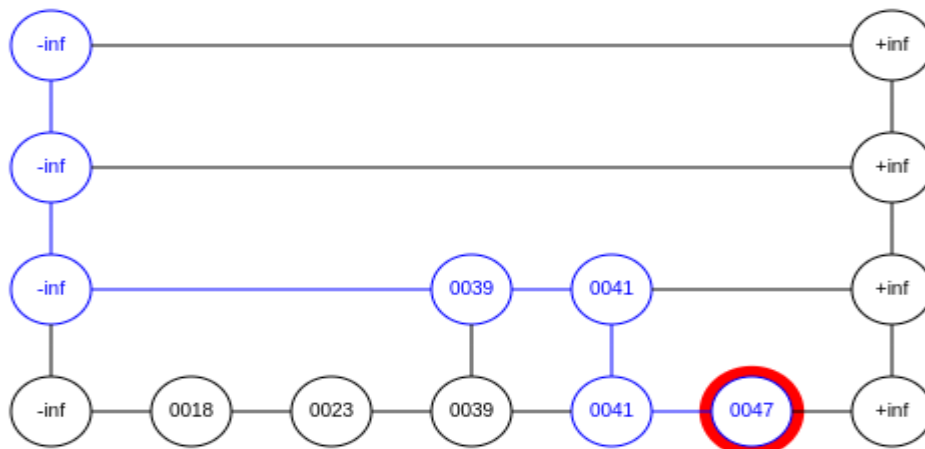-inf ——————————— +inf
-inf ———————— 0041 — +inf
-inf — 0018 — 0023 — 0041 — +inf

Removing.

-inf ——————————— +inf
-inf ——————————— +inf
-inf ———————— 0041 — +inf
-inf — 0018 — 0023 — 0041 — +inf

-inf ——————————— +inf
-inf ——————————— +inf
-inf ———————— 0041 — +inf
-inf — 0023 — 0041 — +inf

removing 41 …
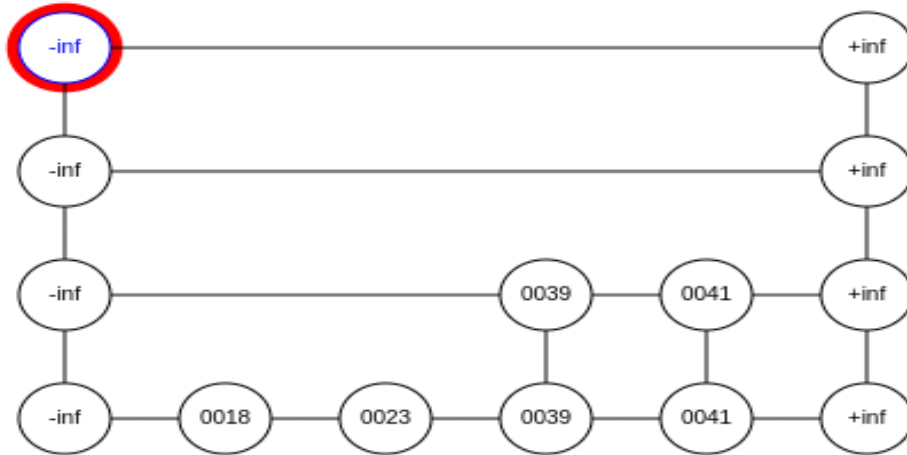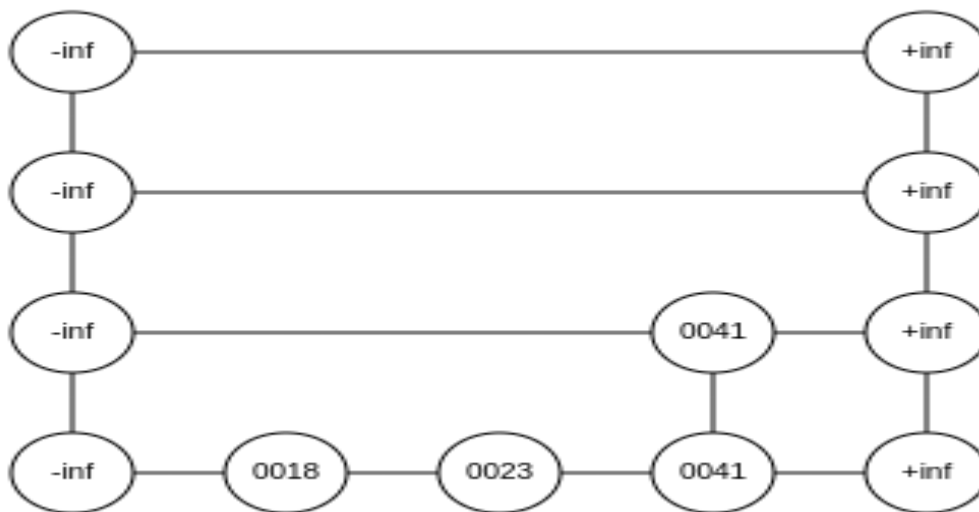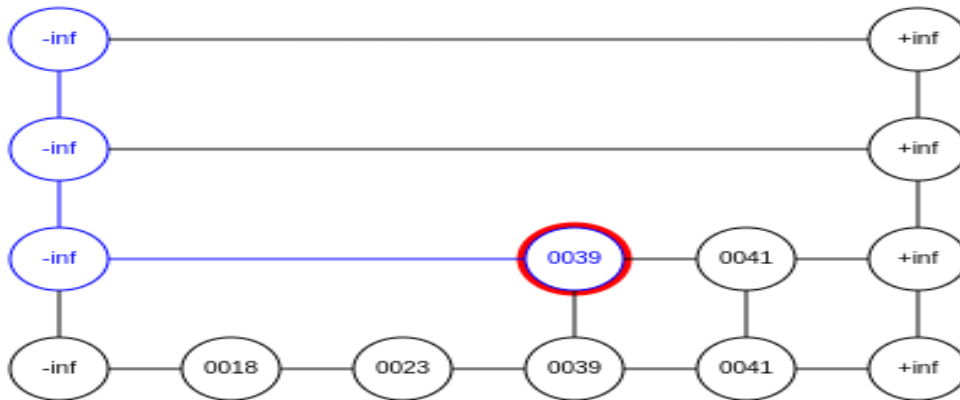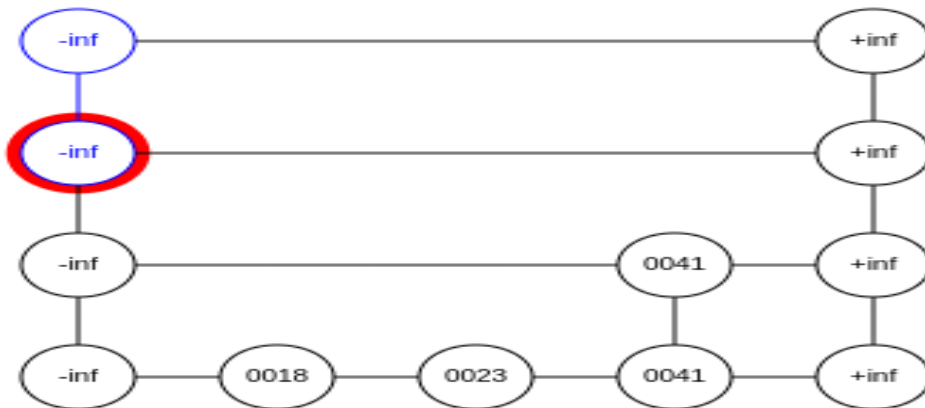
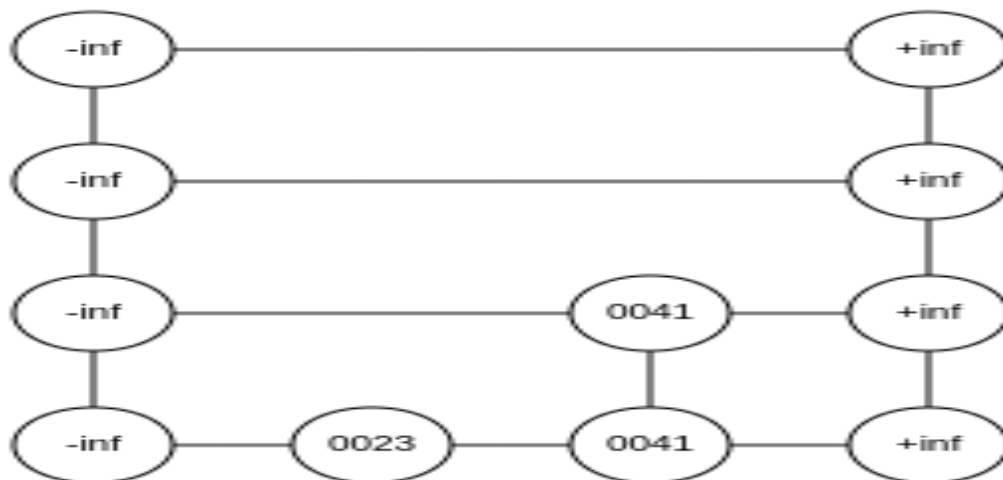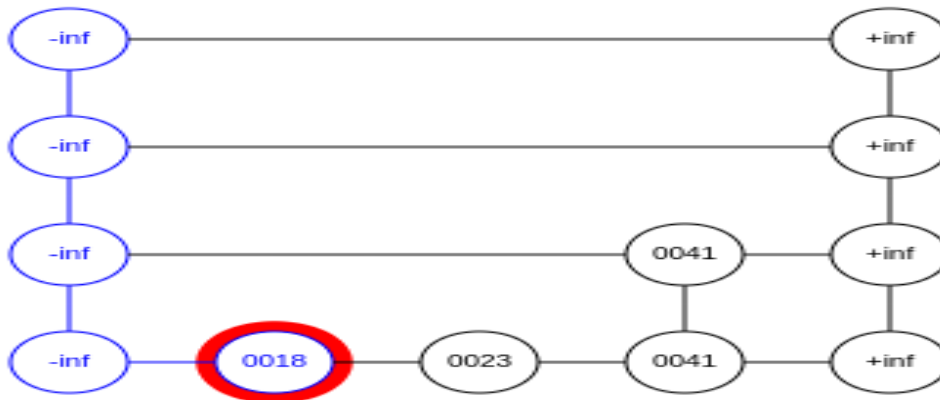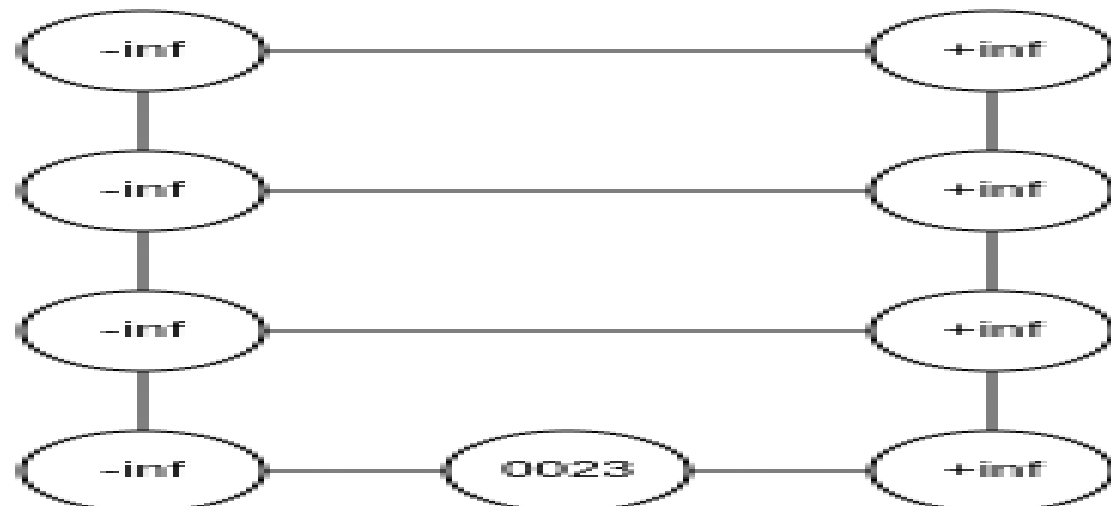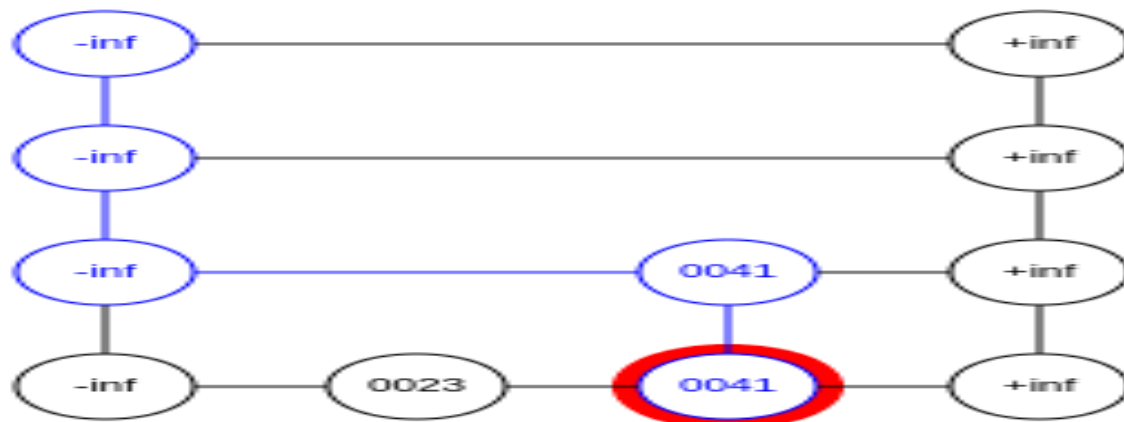Key to right > target; moving down.

Key to right > target; moving down.

removing 23 …
all removed !!!!

- B-Tree with order 4:
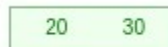
20, 30, 8, 47, 39, 18, 41,23
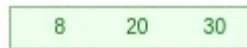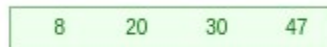
BUILDING B-Tree with order 4:

INSERTING 20 …

| 20 |

INSERTING 30 …

| 20 | 30 |

INSERTING 8 …

| 8 | 20 | 30 |

INSERTING 47 …

| 8 | 20 | 30 | 47 |

INSERTING 39 …

| 8 | 20 | 30 | 39 | 47 |

```
        30
       /   \
  8  20    39  47
```
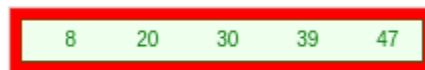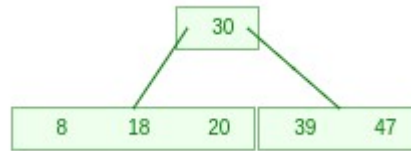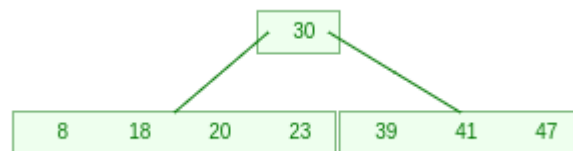
INSERTING 18 …
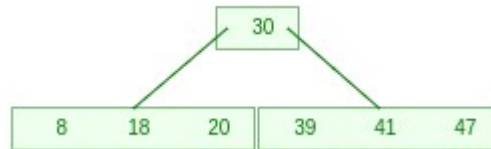
INSERTING 41 …

INSERTING 23 …

removing :

removing 20 …
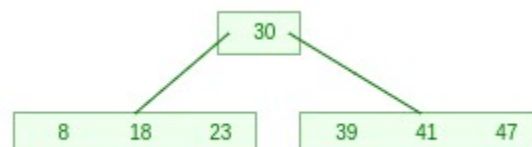
removing 30 …
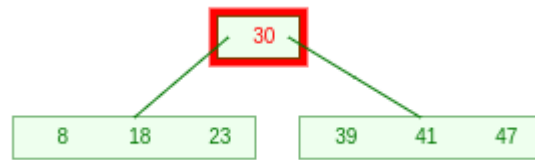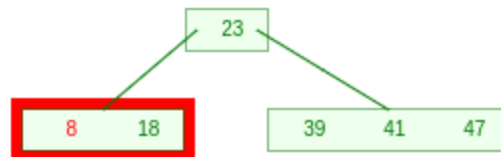
removing 8 …

removing 47 …

removing 39 …

| 18 | 23 | 41 |

removing 18 …

| 23 | 41 |

removing 41 …

| 23 |

removing 23 …

all removed !!!!!!