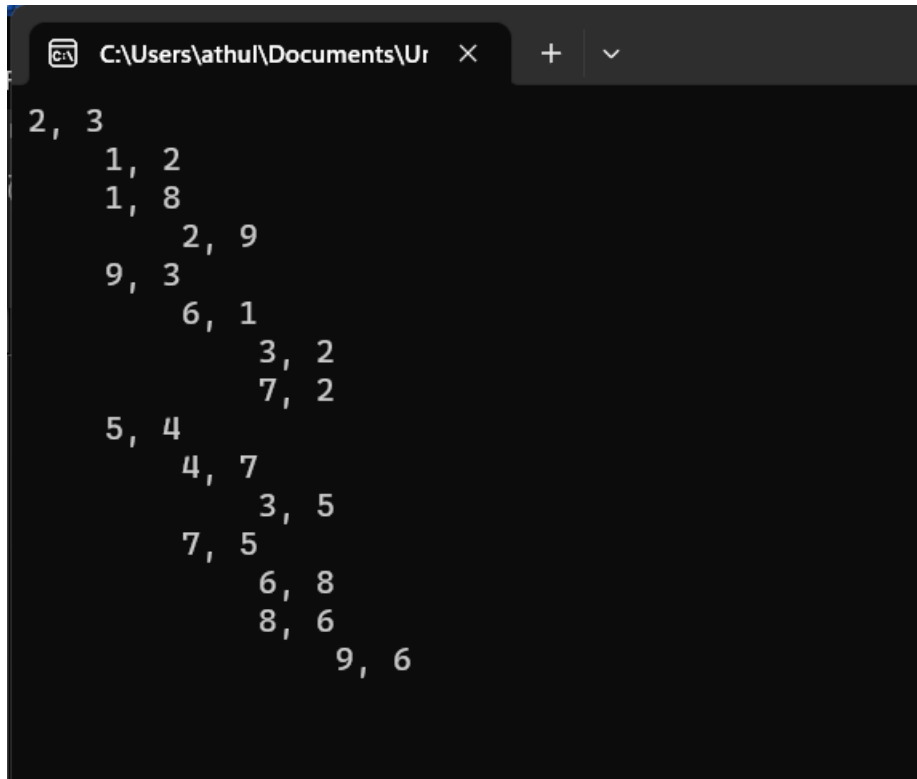# COIS 3020, Winter 2023

Quad Point Tree

Insertion

Values : {2, 3}, { 2, 3}, {5, 4}, {1, 8}, {9, 3}, {6, 1}, {7, 5}, {3, 2}, {4, 7}, {2, 9}, {8, 6}, {3, 5}, {1, 2}, {6, 8}, {7, 2}, {9, 6}

```
2, 3
     1, 2
     1, 8
          2, 9
     9, 3
          6, 1
               3, 2
               7, 2
     5, 4
          4, 7
               3, 5
          7, 5
               6, 8
               8, 6
                    9, 6
```

Deletion

Deleting the root

```
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2, 3
    1, 2
    1, 8
        2, 9
    9, 3
        6, 1
            3, 2
            7, 2
    5, 4
        4, 7
            3, 5
        7, 5
            6, 8
            8, 6
                9, 6

Tree after deleting {2, 3}
1, 2
    1, 8
    6, 1
        3, 2
        7, 2
    2, 9
        9, 3
            5, 4
                4, 7
                    3, 5
                7, 5
                    6, 8
                    8, 6
                        9, 6
```

Deleting a node with a parent and children

```
2, 3
    1, 2
    1, 8
        2, 9
    9, 3
        6, 1
            3, 2
            7, 2
    5, 4
        4, 7
            3, 5
        7, 5
            6, 8
            8, 6
                9, 6

Tree after deleting {5, 4}
2, 3
    1, 2
    1, 8
        2, 9
    9, 3
        6, 1
            3, 2
            7, 2
    4, 7
        3, 5
        7, 5
            8, 6
                9, 6
        6, 8
```

Deleting a leaf node

```
2, 3
    1, 2
    1, 8
        2, 9
    9, 3
        6, 1
            3, 2
            7, 2
    5, 4
        4, 7
            3, 5
        7, 5
            6, 8
            8, 6
                9, 6

Tree after deleting {9, 6}
2, 3
    1, 2
    1, 8
        2, 9
    9, 3
        6, 1
            3, 2
            7, 2
    5, 4
        4, 7
            3, 5
        7, 5
            6, 8
            8, 6
```

Trying to delete a node that doesn't exist.

```
2, 3
    1, 2
    1, 8
        2, 9
    9, 3
        6, 1
                3, 2
                7, 2
    5, 4
        4, 7
                3, 5
        7, 5
            6, 8
            8, 6
                    9, 6

Node doesnt exist
```

Contains

```
2, 3
    1, 2
    1, 8
        2, 9
    9, 3
        6, 1
            3, 2
            7, 2
    5, 4
        4, 7
            3, 5
        7, 5
            6, 8
            8, 6
                9, 6

Contains {9, 6}
```

```
2, 3
    1, 2
    1, 8
        2, 9
    9, 3
        6, 1
            3, 2
            7, 2
    5, 4
        4, 7
            3, 5
        7, 5
            6, 8
            8, 6
                9, 6

Contains {1, 8}
```