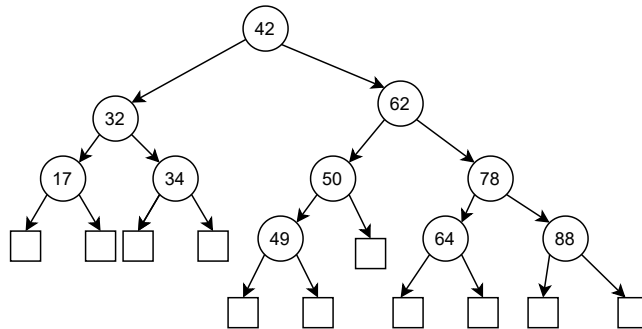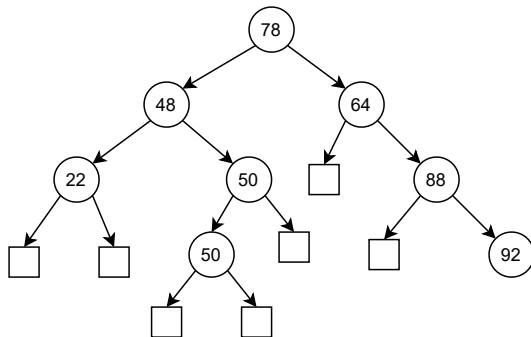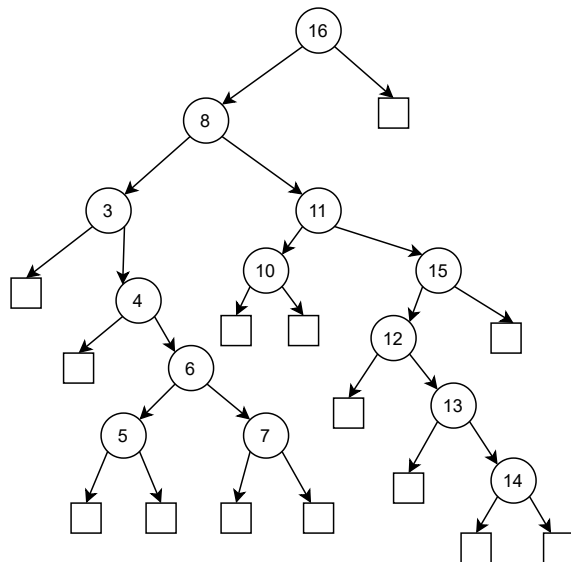AS 9 - Balanced Trees

#1 Insertion in this AVL tree

Wesley Chok
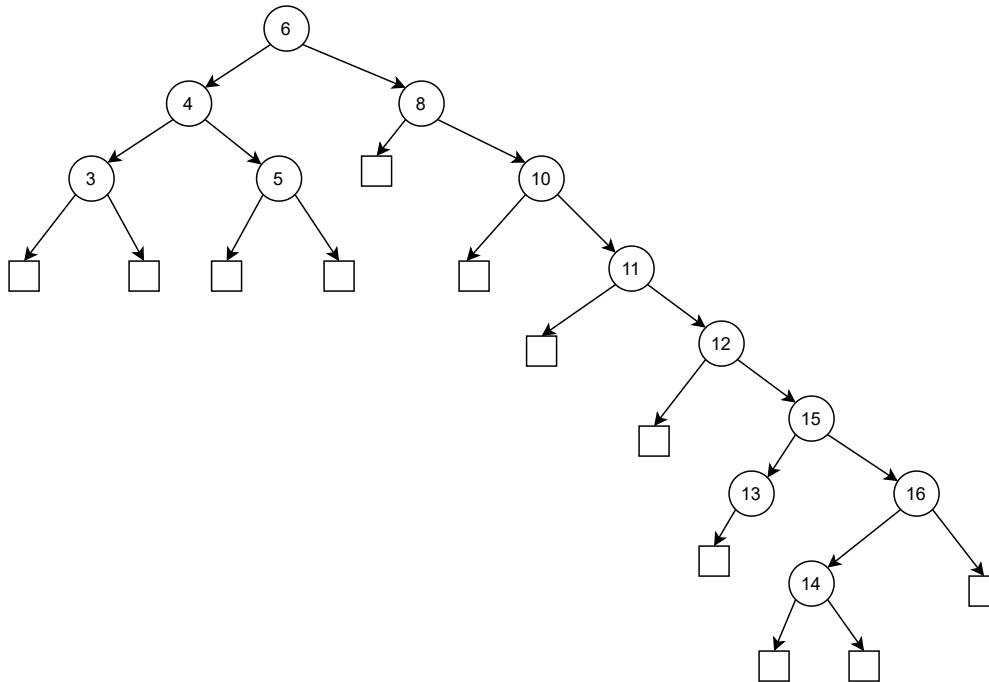2:30 - 4:50 pm
CS1D



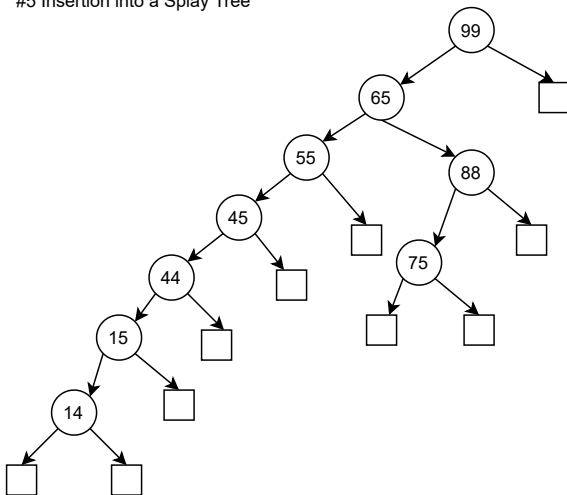#2 Removal from this AVL tree



#3 Splaying
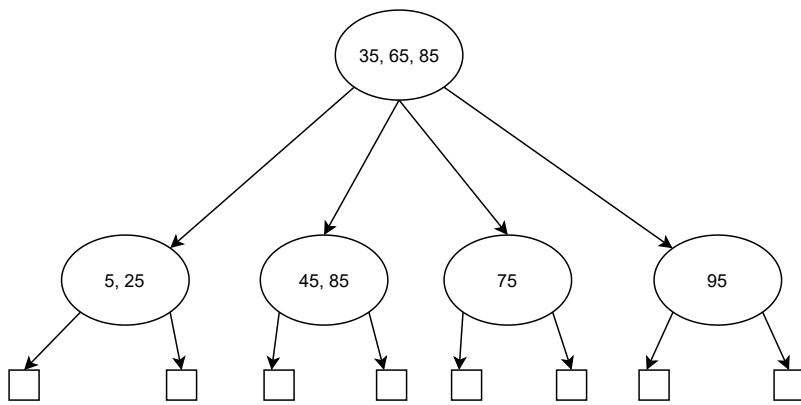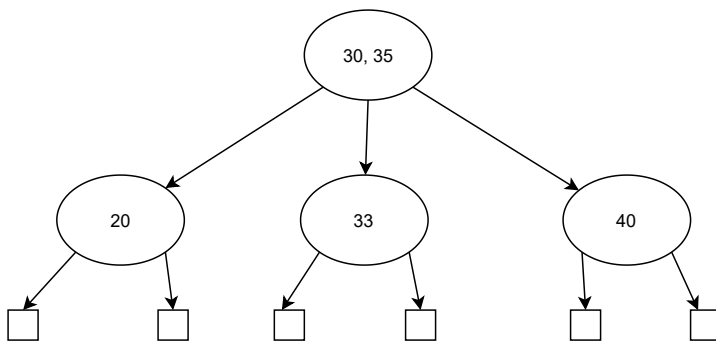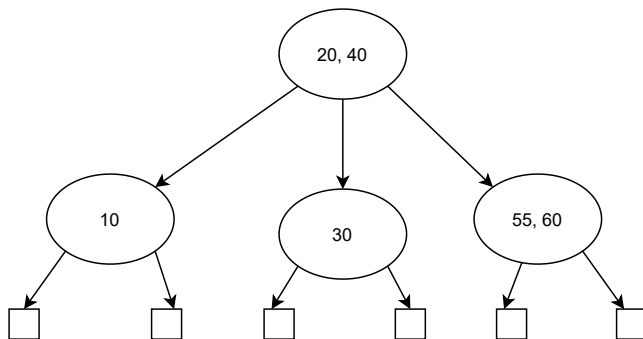
#4 Splaying



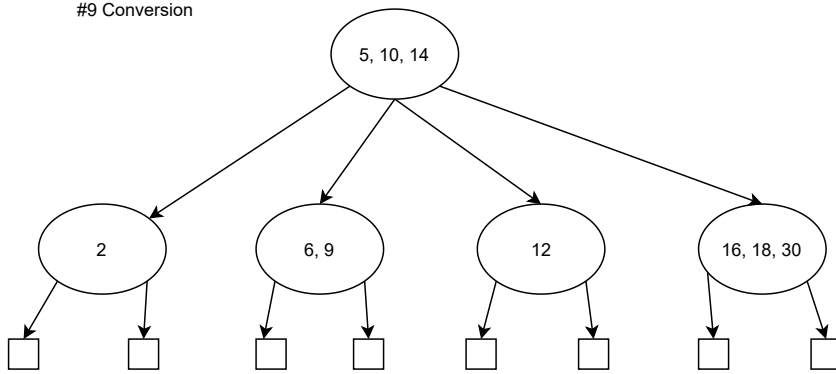#5 Insertion into a Splay Tree

#6 Insertion into a 2-4 Tree

```
                        ┌─────────────┐
                        │  35, 65, 85 │
                        └─────────────┘
          ┌──────────────┬────────┴────────┬──────────────┐
      ┌───────┐      ┌────────┐        ┌───────┐       ┌───────┐
      │ 5, 25 │      │ 45, 85 │        │  75   │       │  95   │
      └───────┘      └────────┘        └───────┘       └───────┘
      ┌┐    ┌┐        ┌┐   ┌┐           ┌┐   ┌┐          ┌┐   ┌┐
      └┘    └┘        └┘   └┘           └┘   └┘          └┘   └┘
```

#7 Delete from a 2-4 Tree

```
                    ┌────────┐
                    │ 30, 35 │
                    └────────┘
          ┌────────────┼─────────────┐
       ┌──────┐     ┌──────┐      ┌──────┐
       │  20  │     │  33  │      │  40  │
       └──────┘     └──────┘      └──────┘
       ┌┐    ┌┐     ┌┐    ┌┐      ┌┐    ┌┐
       └┘    └┘     └┘    └┘      └┘    └┘
```

#8 Delete from a 2-4 Tree

```
                    ┌────────┐
                    │ 20, 40 │
                    └────────┘
          ┌────────────┼─────────────┐
       ┌──────┐     ┌──────┐      ┌────────┐
       │  10  │     │  30  │      │ 55, 60 │
       └──────┘     └──────┘      └────────┘
       ┌┐    ┌┐     ┌┐    ┌┐      ┌┐    ┌┐
       └┘    └┘     └┘    └┘      └┘    └┘
```

#9 Conversion

```
                    5, 10, 14

       2        6, 9        12      16, 18, 30
      □ □      □ □        □ □       □ □
```

#10 Insertion into a Red-Black
           Tree

```
                    45
           25              55
       5       35      65      95
      ■ ■    ■ ■      ■          ■ ■
                   55      75
                  ■ ■    ■ ■
```
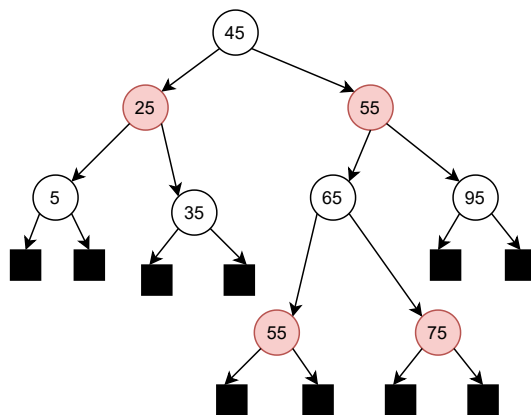
#11 Remove from a Red-Black
           Tree

```
                    50
           33              60
       ■       44      ■       ■
              ■ ■
```
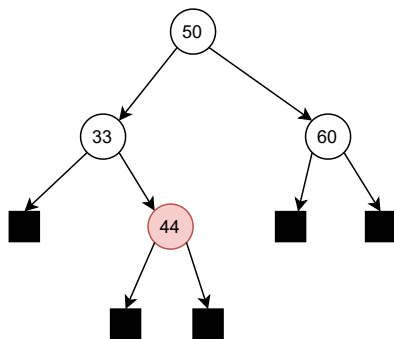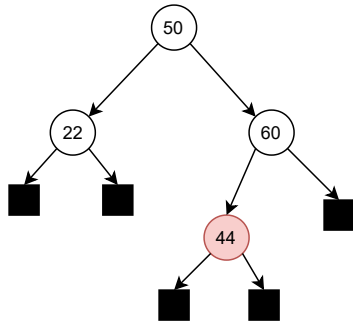
#12 Remove from a Red-Black
Tree



#13 Remove From a Red-
Black Tree