



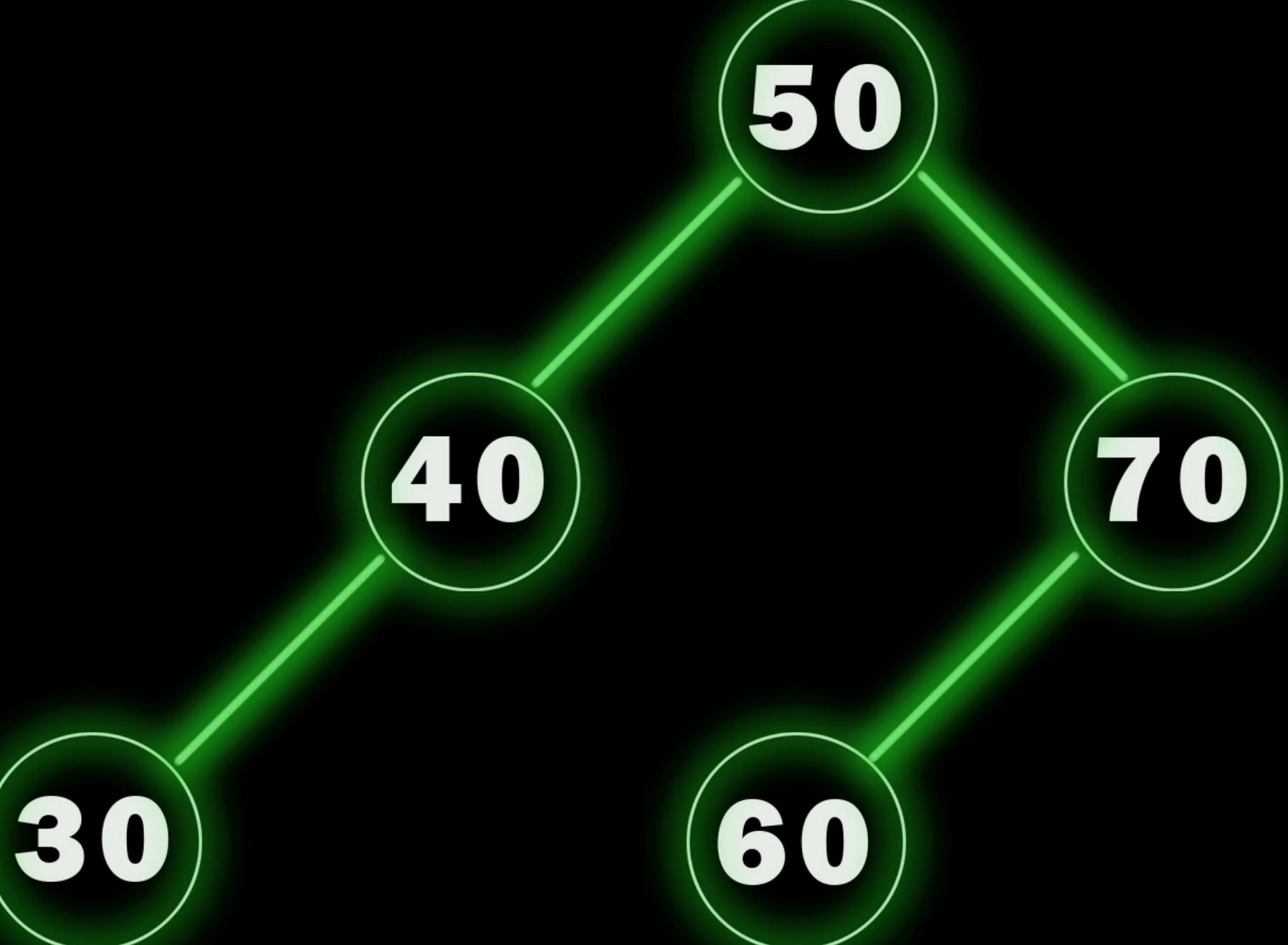
INTRODUCTION

Arena of Ratings uses a **Binary Search Tree (BST)** for instant matchmaking. Unlike slow standard lobbies, it ensures pairing takes **milliseconds**, even with thousands of players.

OBJECTIVE

High-Performance Matchmaking Engine
Instant Match
Dynamic Ranking
Seamless Player Management at Scale

METHODS



```

struct Node {
    int rating;
    std::string name;
    long long hp;
    Node *left, *right;
    int sz;

    Node(int r, std::string n,
          : rating(r), name(n),
    };
  
```

- JOIN r n h (Add)
- LEAVE r (Remove)
- STATUS r (Info)
- DAMAGE r amt
- HEAL r amt
- MATCH X (Closest)
- NEXT X (Successor)

RESULTS

Time Complexity: $O(h)$
Space Complexity:
 $O(N)$ space efficiency.
Real-Time Feedback:
Uses ANSI color codes
for Success, Red for Error).

```

Welcome to the Arena of Ratings Engine.
Type 'HELP' for a list of commands.

Arena> JOIN 400 KF 4
JOINED
Arena> JOIN 200 KF 4
JOINED
Arena> JOIN 100 KF 4
JOINED
Arena> JOIN 50 KF 4
JOINED
Arena> JOIN 150 KF 4
JOINED
Arena> JOIN 300 KF 4
JOINED
Arena> VISUAL

--- VISUAL TOPOLOGY ---
[400] KF (4HP)
|__ [200] KF (4HP)
   |__ [100] KF (4HP)
      |__ [50] KF (4HP)
         |__ [150] KF (4HP)
            |__ [300] KF (4HP)

Arena> 
  
```

```

Welcome to the Arena of Ratings Engine.
Type 'HELP' for a list of commands.

Arena> HELP
== ARENA OF RATINGS: COMMAND LIST ==
VISUAL : Draw the tree structure
SAVE <file> : Save arena to disk
LOAD <file> : Load arena from disk
JOIN <r> <n> <h> : Add a player
LEAVE <r> : Remove a player
STATUS <r> : Show player details
DAMAGE <r> <a> : Reduce player HP
HEAL <r> <a> : Increase player HP
MATCH <r> : Find closest opponent
NEXT <r> : Find next higher player
PREV <r> : Find next lower player
RANGE <L> <R> : List players in range
RANK <r> : Count players with less than or equal to rating
KTH <k> : Find k-th smallest player
DUEL <A> <B> : Measure tree distance between two nodes
STATS : Show system diagnostics
CLEAR : Clear the screen
EXIT : Quit the program
=====

Arena> 
  
```

```

Arena> LEAVE
Error: Usage LEAVE <rating>
Arena> LEAVE 0
NOT FOUND
Arena> LEAVE 100
LEFT
Arena> 
  
```

CONCLUSION

```

Arena> STATS
PLAYERS 0
MIN NONE
MAX NONE
HEIGHT -1
LEAVES 0
Arena> 
  
```

The Arena of Ratings demonstrates the power of BSTs for real-time matchmaking. By achieving $O(\log N)$ efficiency, the engine guarantees instant pairing and dynamic ranking, solving the latency issues found in standard linear systems.

ACKNOWLEDGEMENTS

I express my gratitude to my instructor for their mentorship in designing the efficient algorithms used in this project.