



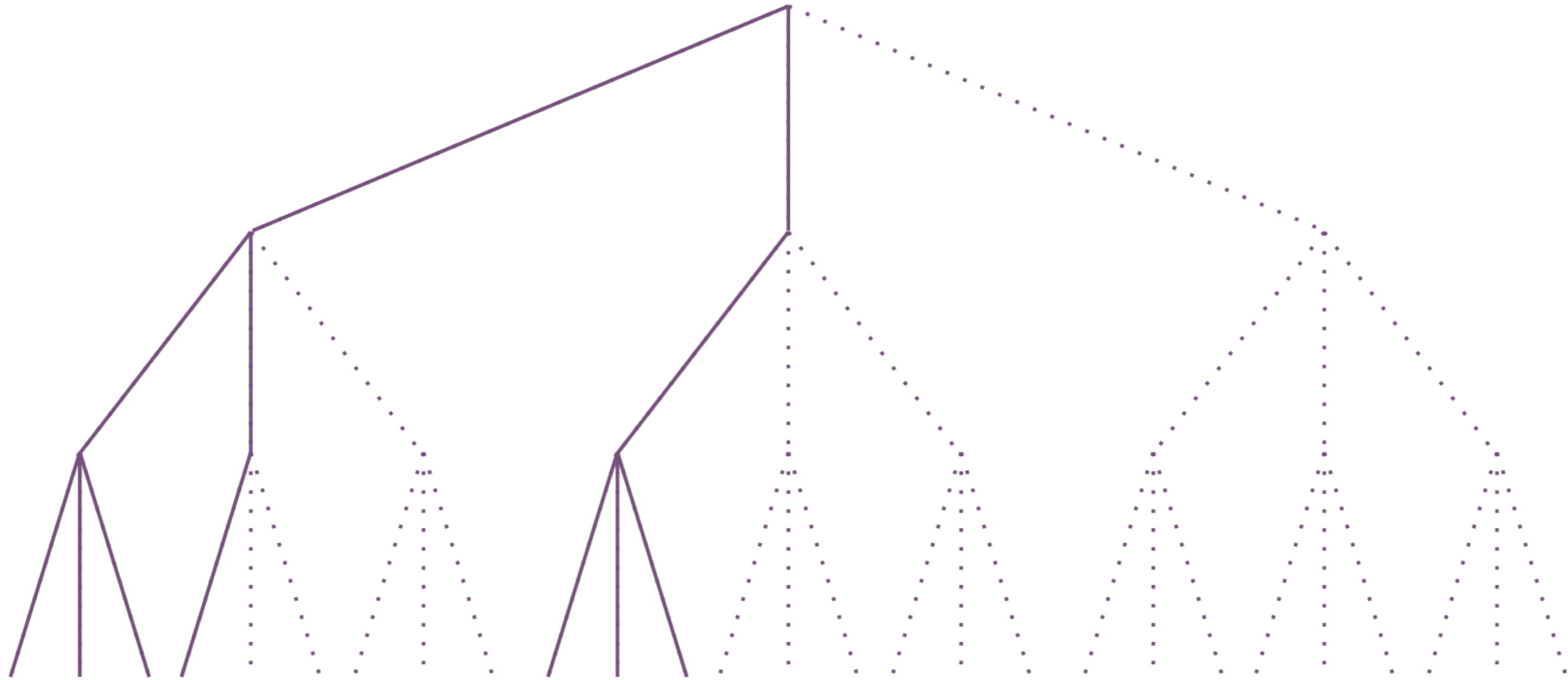
Team Unicode Snowman Plays Kalah

# Tree Searching

$\alpha\beta$

$\alpha\beta$  Negamax

mtd(f)



# Transposition Table

- Store game values in cache
- Use to order moves
- Prunes 33% more nodes
- Adds Overhead

# Parallel Search

The logo for SpiNNaker is a purple, stylized shape that resembles a curved arrow or a wing. It is positioned in the center of the slide, below the title. The text "SpiNNaker" is written across the middle of this shape. "Spi" is in purple, "NN" is in yellow, and "aker" is in purple.

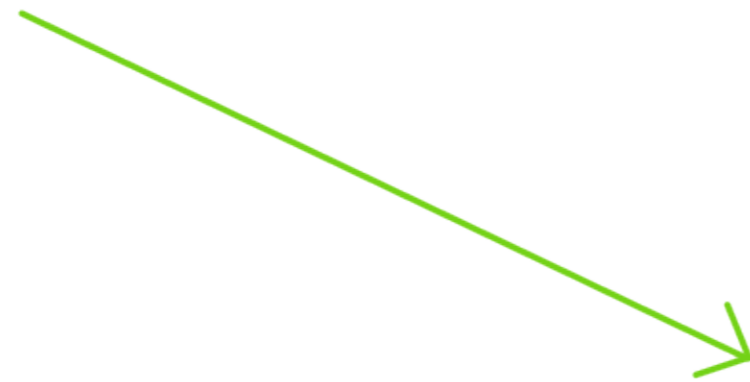
**SpiNNaker**

# Multi-Depth Search

Max Depth  
**3**

Max Depth  
**5**

Max Depth  
**7**

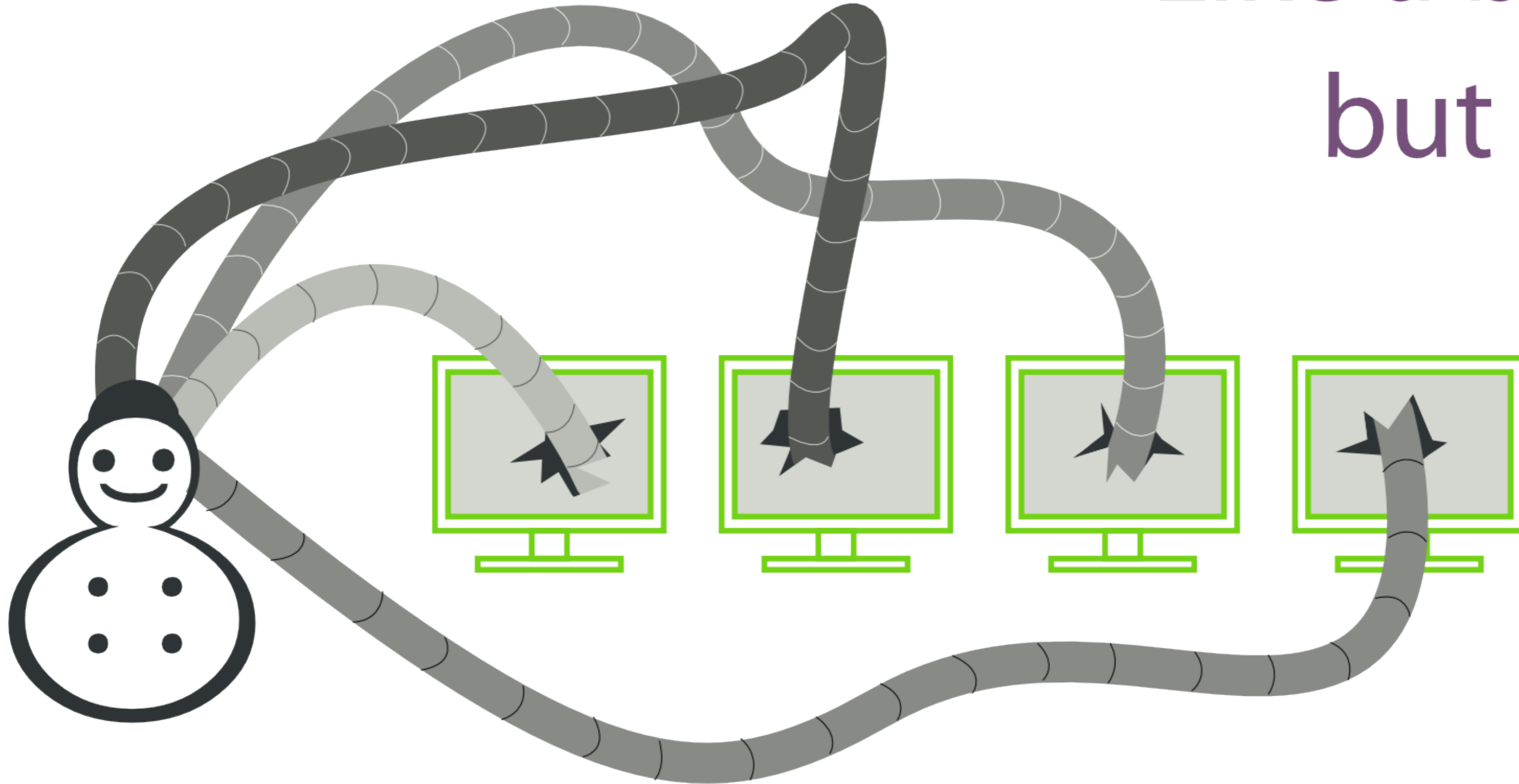


**Arbiter**



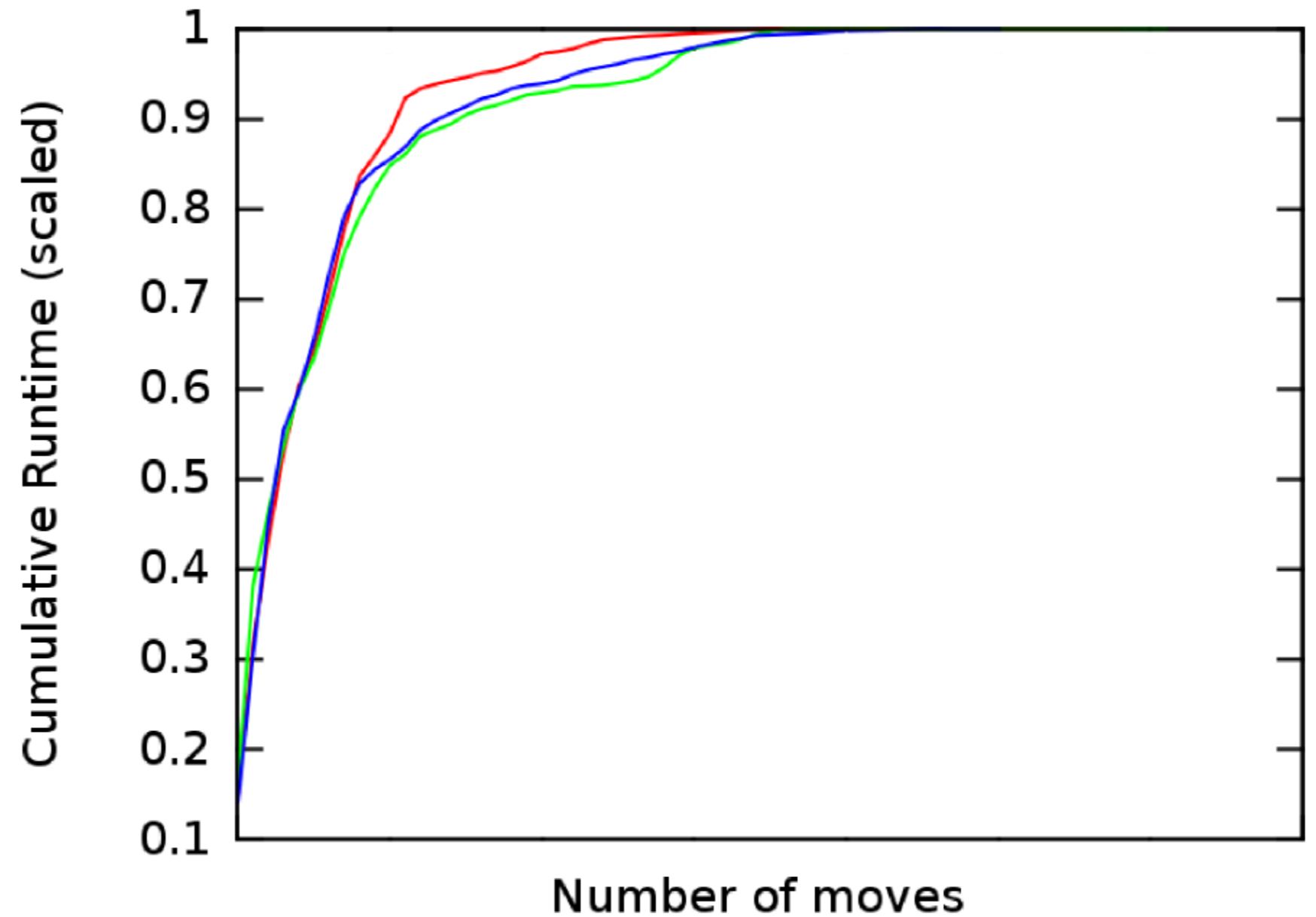
# Cluster-o-Matic

"Like a botnet  
but legal"

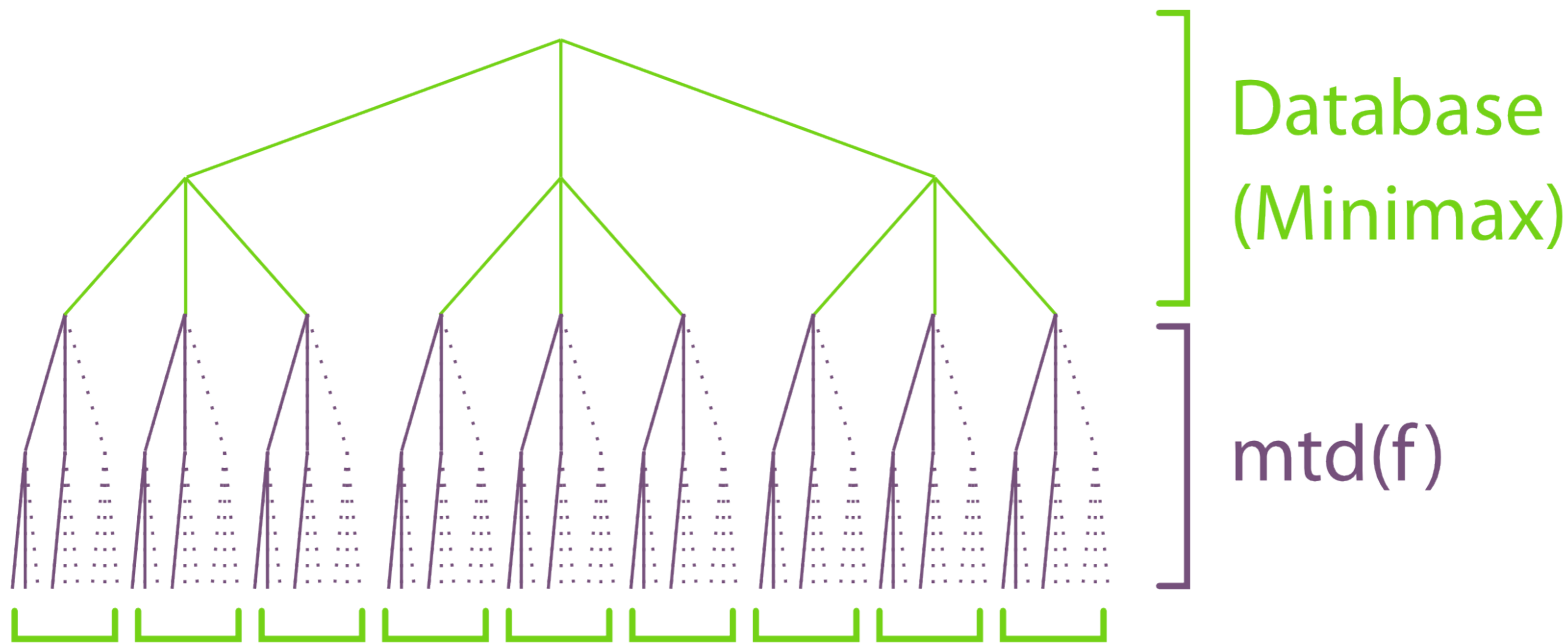


# Start-Game Database

- Precompute deeper
- Save Time



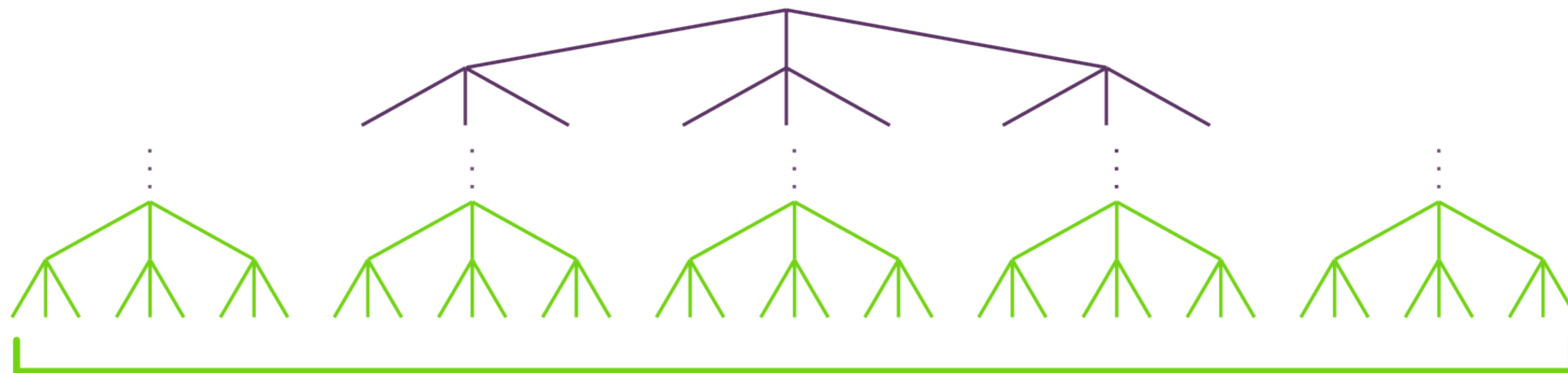
# Start-Game Database



Embarrassingly Parallel



# End-Game Database



Lots of Leaves

- Many Duplicate States
- Compute with Dynamic Programming

# Perfect Hashing

- Data 40x Smaller
- Search always  $O(1)$
- No lookup for `in_database()`

# Using the End-Game DB

- Incompatible with heuristic
- Time-limited-only Search

# Two Heuristics

## Move Ordering

Improves pruning  
and depth

## Game Values

Improves actual  
performance

# Game Value Heuristic

- Extract various features
- Weighted
- Good heuristic very important compared to depth



Any Questions?