Monte-Carlo Search Algorithms

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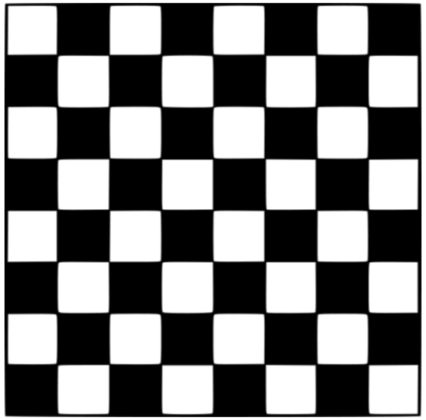
Outline

- Chess and Go
  - Large Game Trees
- Current Monte-Carlo Algorithms
- Current Codebases & Our Additions
  - Fuego
  - Gomba

Chess and Go

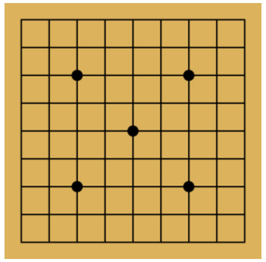


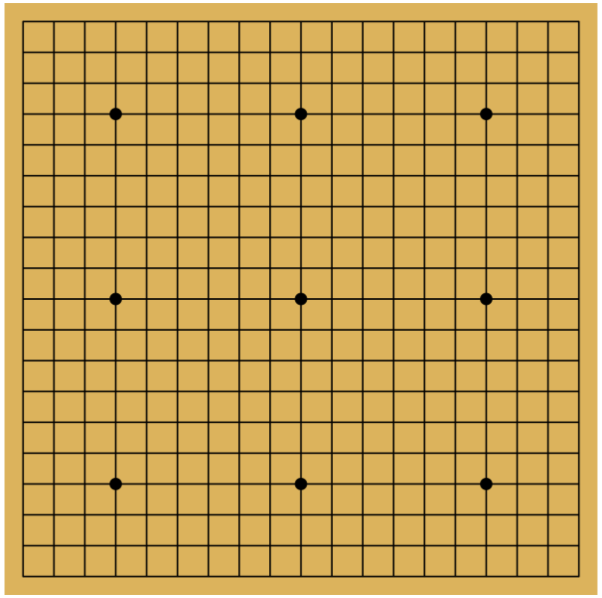
Chess

- Long established in AI
- Large Branching Factor,
  - Fixed board size (8x8)
- Games converge to win or loss

Go

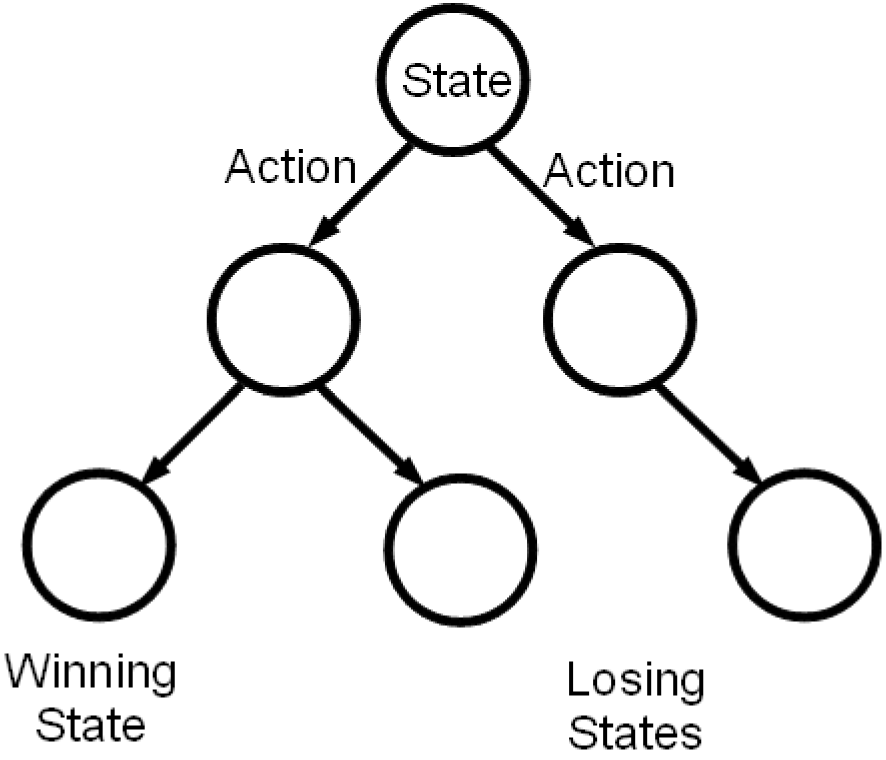
- Used in AI More Recently
- Very Large Branching Factor
  - Varying Board Size (9x9 to 19x19)
- Games take much longer to converge





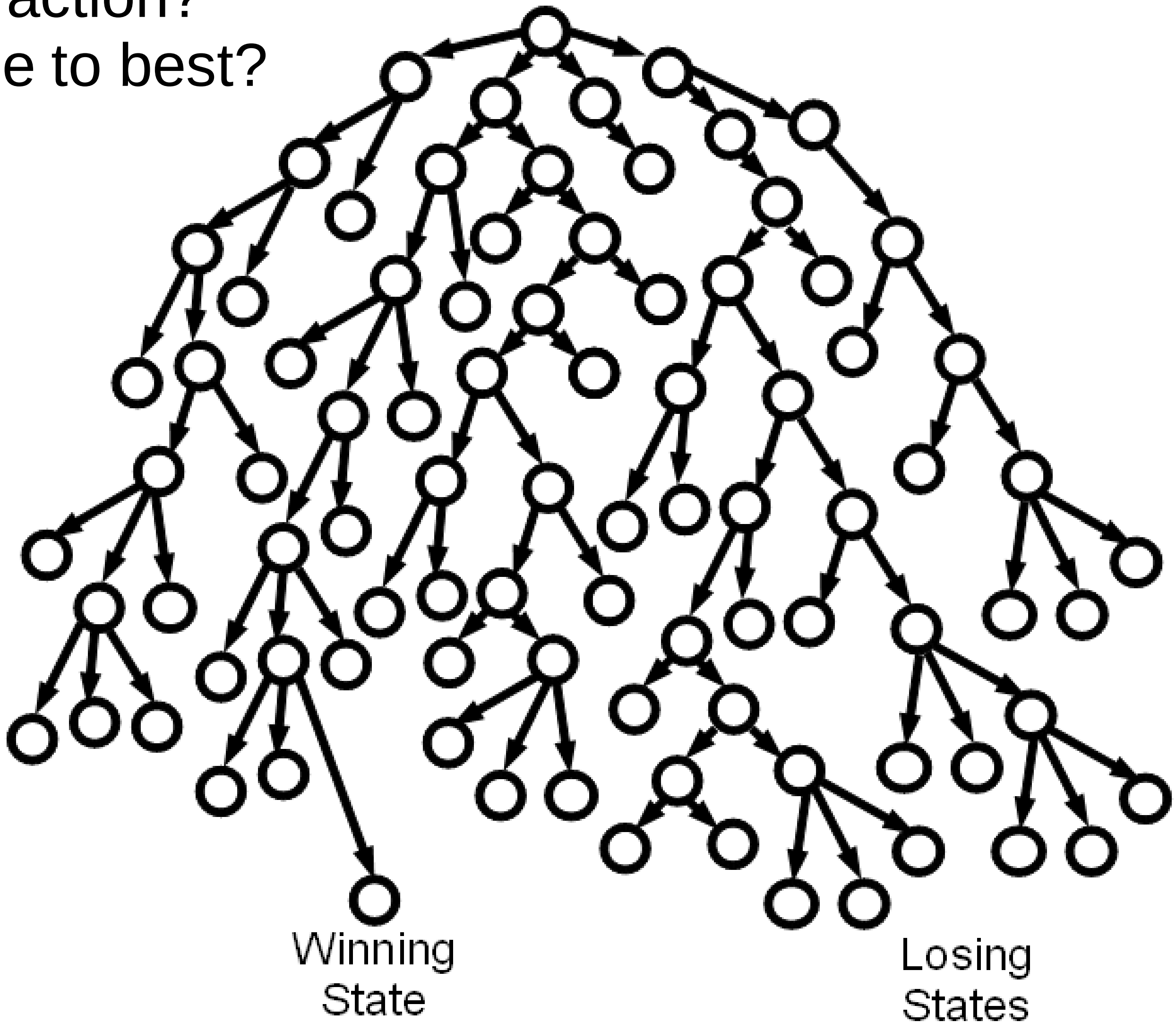
Game Trees

- Consist of States and Actions
- Picking an Action leads to a new State
- Find a winning state, choose the action leading to it



Large Game Trees

- Also consist of States and Actions
- How do you find the best action?
- How do you find one close to best?



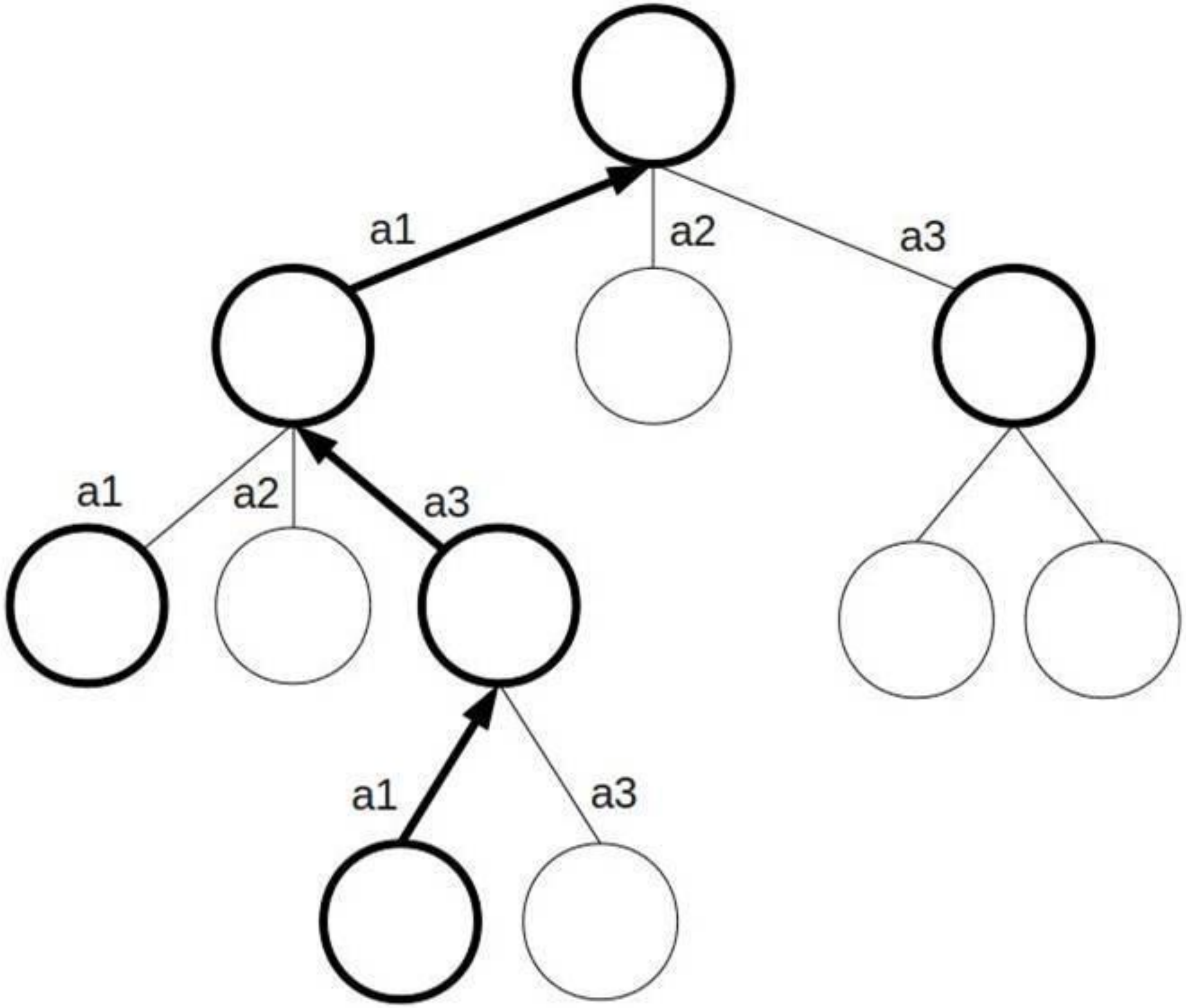
UCT

- Upper Confidence Trees
- “Multi-Armed Bandit”
  - Simulated Regret
- Property of “Upper Confidence Bounds”
  - Balances Exploration Through Tree
- What this means
  - Always exploring the current best move
  - Converges towards optimal choice

UCT-RAVE

- Rapid Action Value Estimation (RAVE)
- Extension of basic UCT
- Updates the values across multiple states, rather than maintains the value on a per-action-state basis.
- AMAF (all moves as first) is a general name for this type of heuristic.

UCT-RAVE

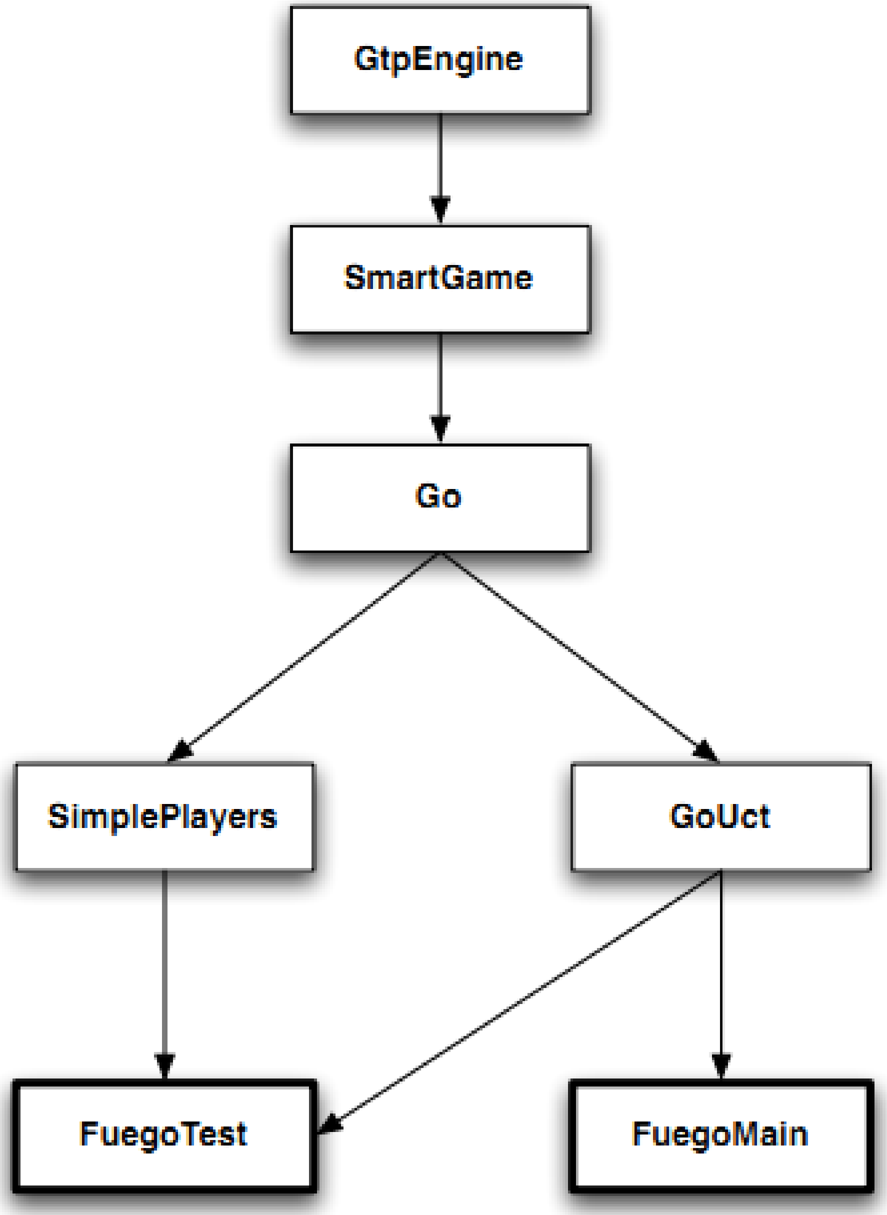


Implementation - Fuego

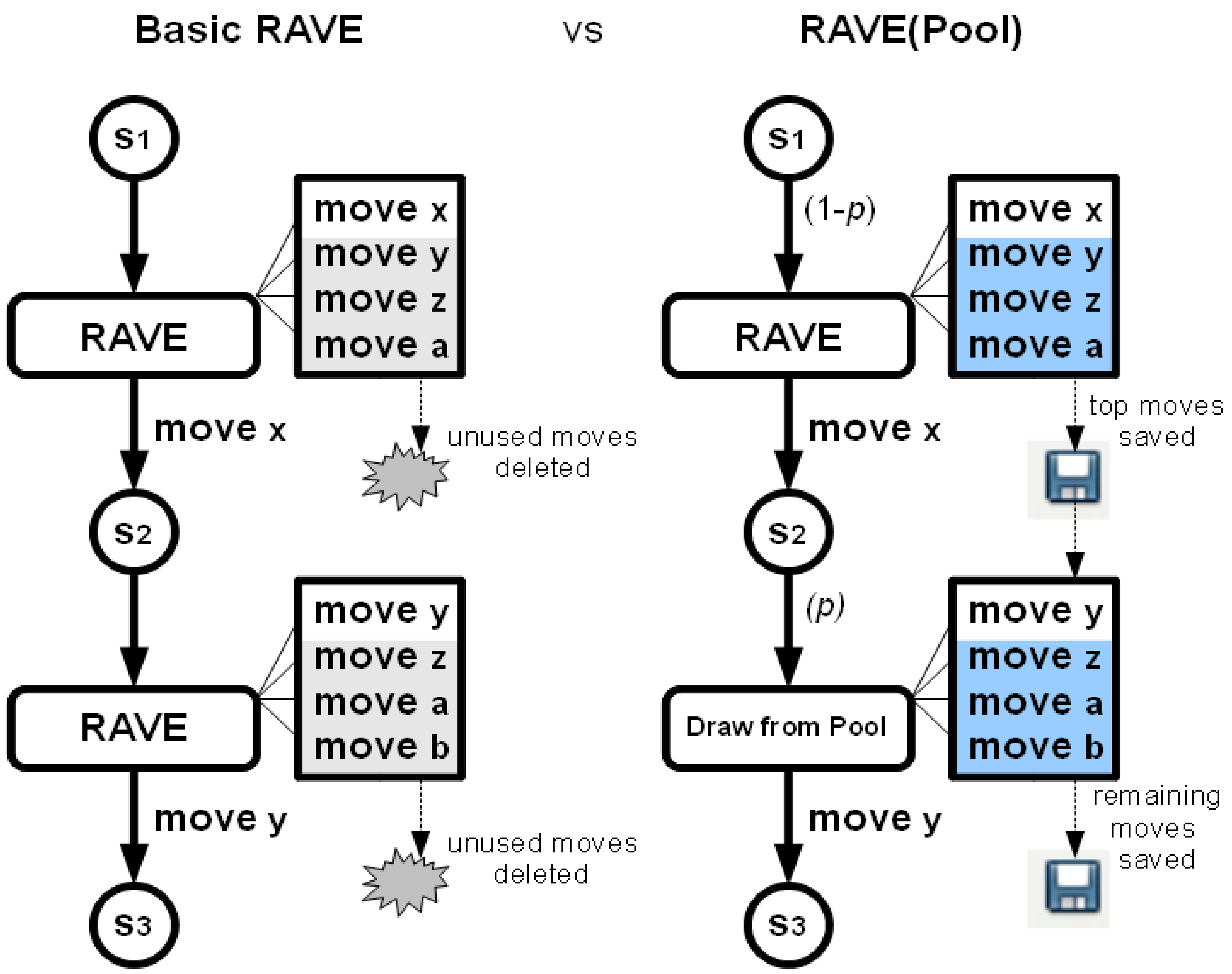
- Pre-Existing Library of Go Algorithms
- UCT-RAVE already implemented
- Uses Go Text Protocol (GTP)to play against
  - Other Go Programs
    - GnuGo, MoGo
  - Humans
    - GoGui
- First program to defeat a 7 Dan Go player in 9x9 Go.

Fuego - Framework

- Large Codebase
- Only One External Library
- Multi-Threaded
- Open Source
- Extendable



Fuego - Experiments



Time = 2T

Time = T + t

Disadvantages

Fuego et al. take a very long time to test.

- Play against separate algorithm for many games
- Change parameters
- Play again

Effectiveness of a new algorithm difficult to prove.

- Parameters difficult to optimize.

Cluster Jobs / Parallel Testing improves response of results

There is an alternative.

Artificial Game Tree

- Faster speed
- Better heuristic
- Easily twisted parameters (branching factors, depth, etc.)

Gomba

- Developed by Daniel Bjorge and John Schaeffer in 2010
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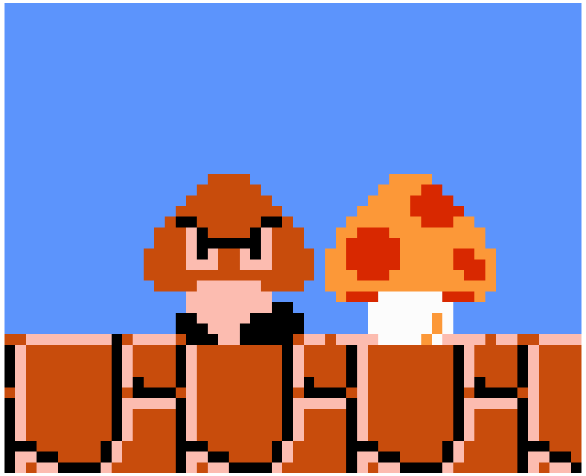
- Mini-max Artificial Game Tree
- Lazy State Expansion
- Fast Action Simulation
- Fast Termination Evaluation
- Fast Heuristic Evaluation
- ... ...



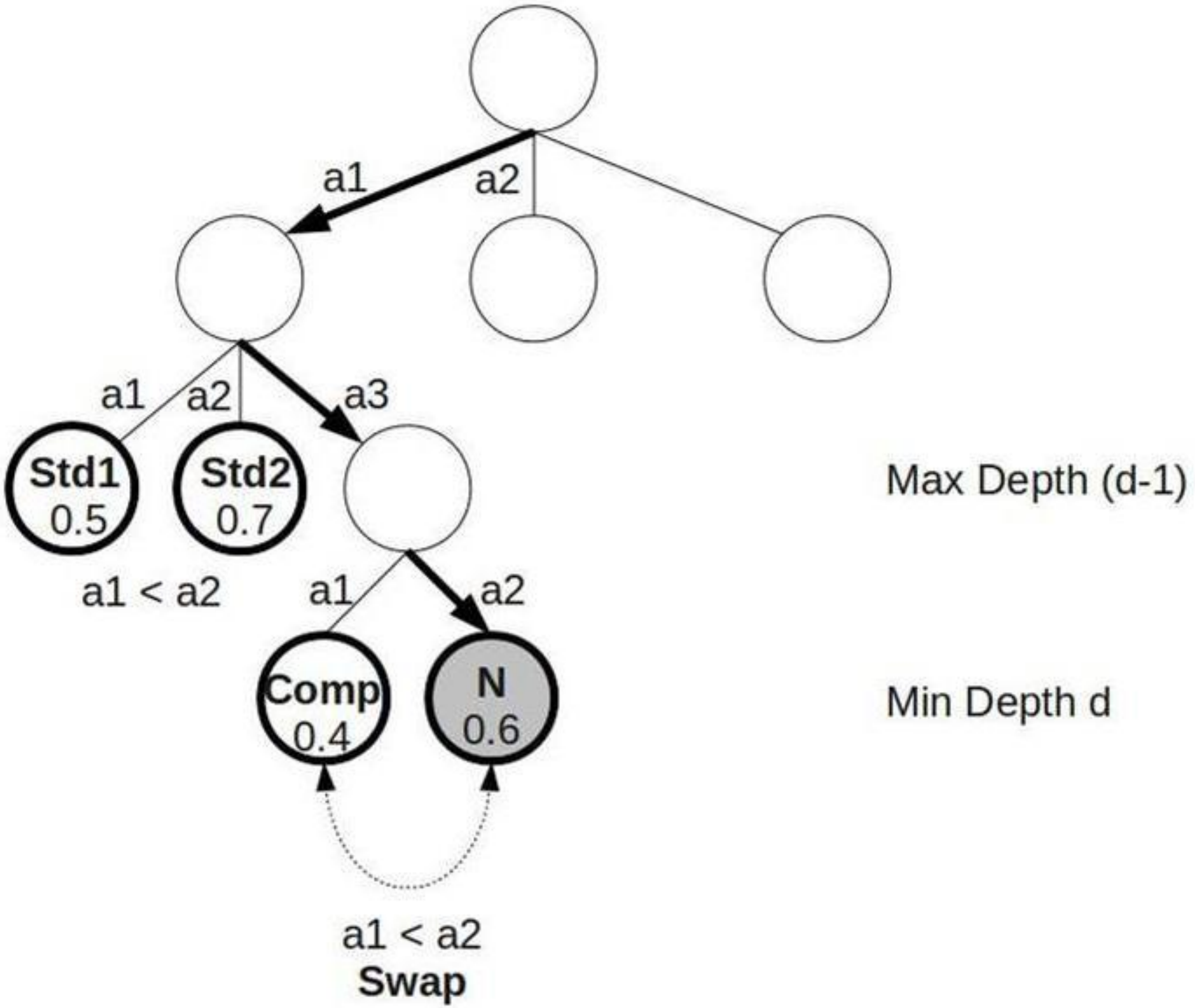
Problem with Gomba

- AMAF algorithms - UCT RAVE algorithm
  - transposition table
  - global knowledge of the moves
- Structure of Gomba cannot support this type of algorithms

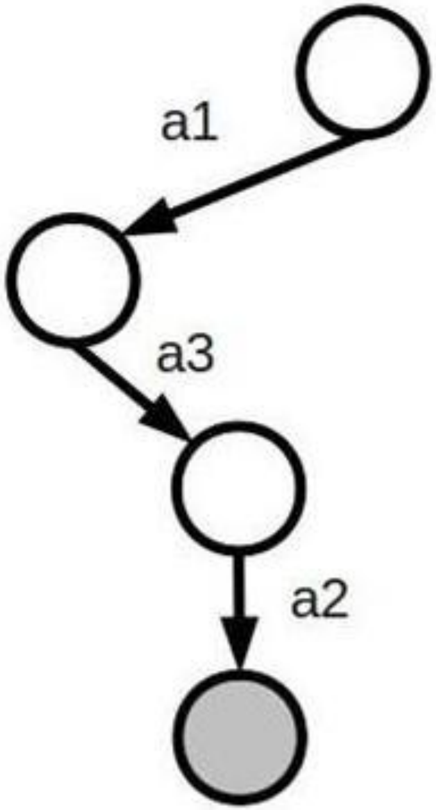
Our improvements

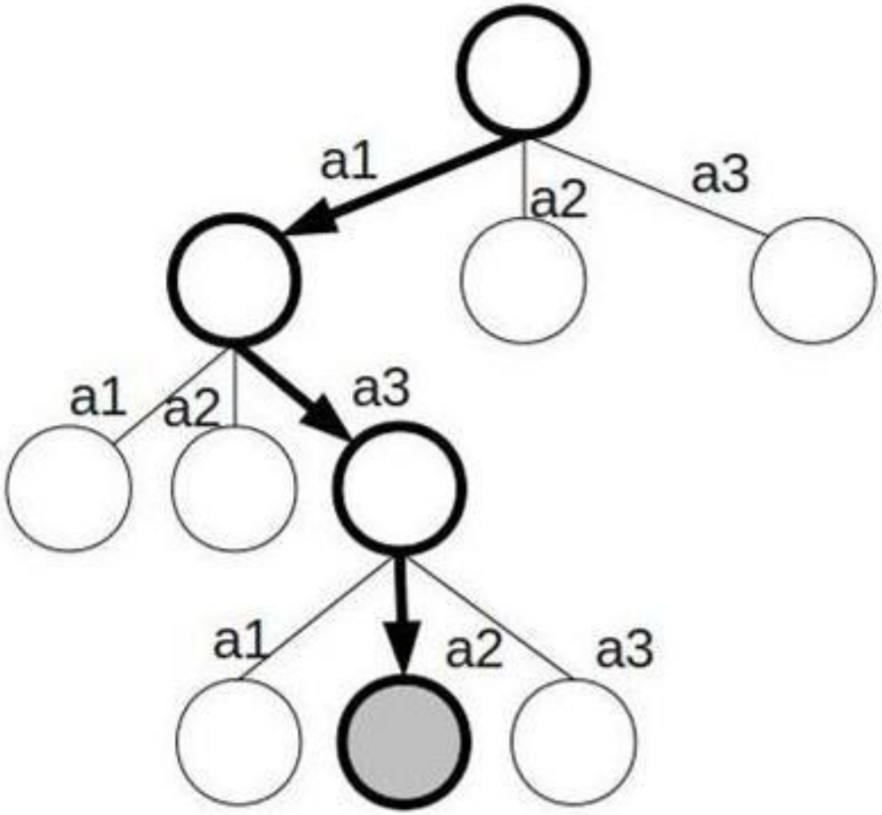
- Modified the tree structure to better support AMAF algorithms
- Add global knowledge of the moves
- Better correlation and consistency among the moves
- Modification to the lazy state expansion

Correlations among the moves



Adjust to the tree structure

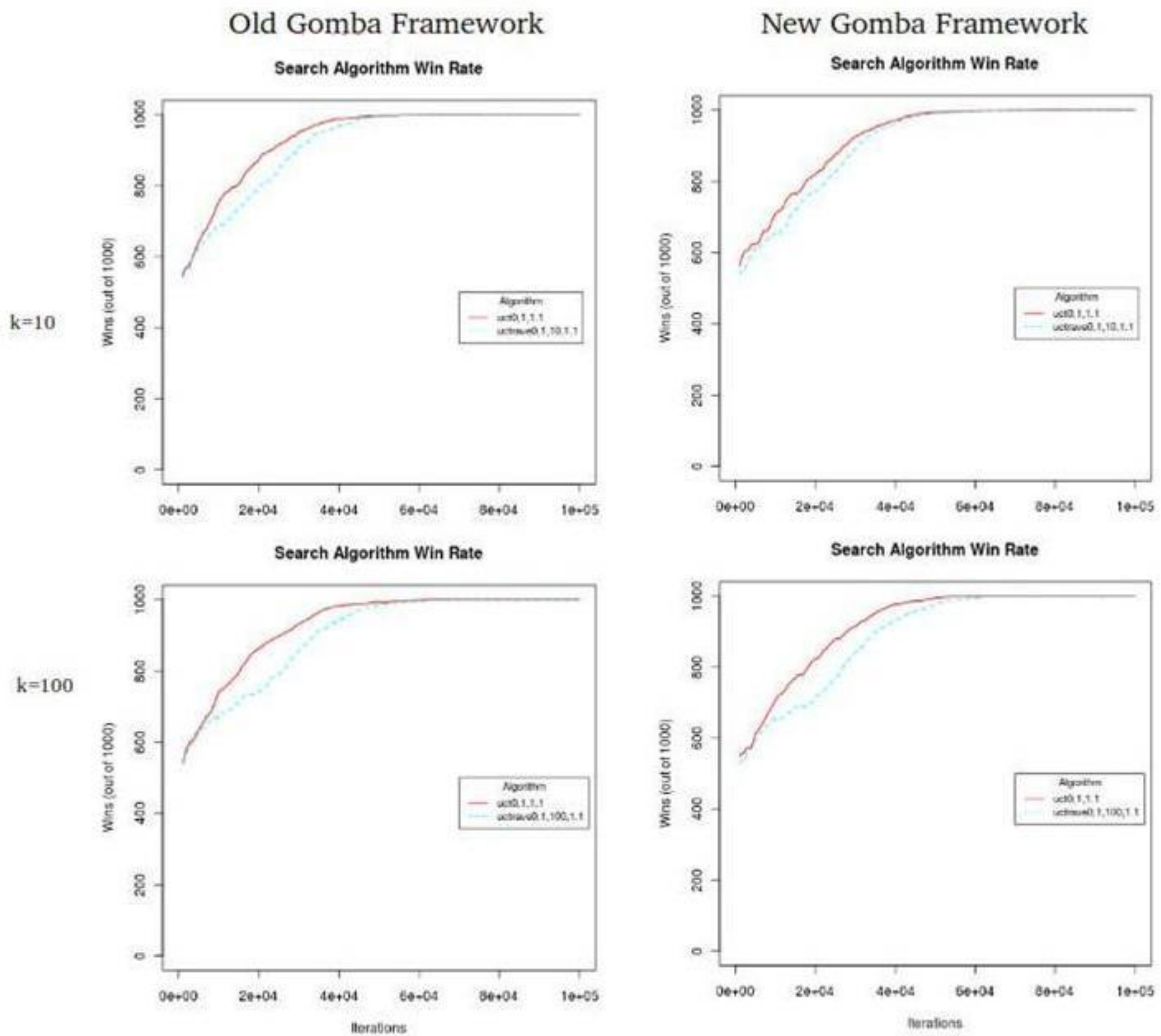




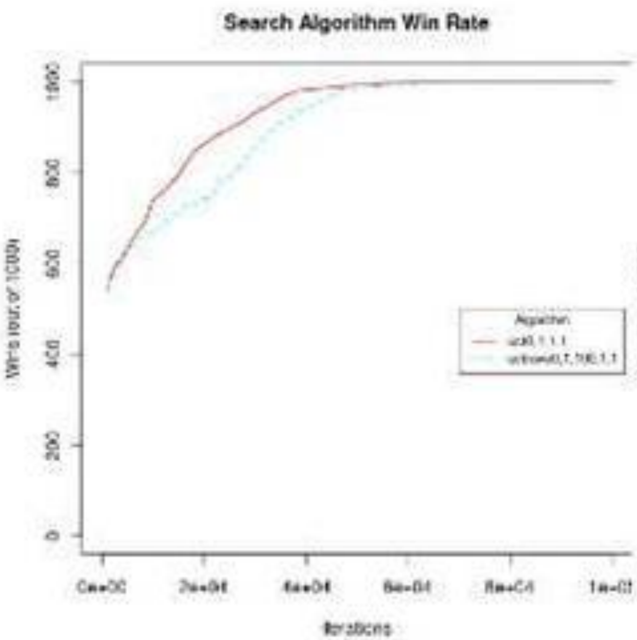
Original lazy state expansion

New lazy state expansion

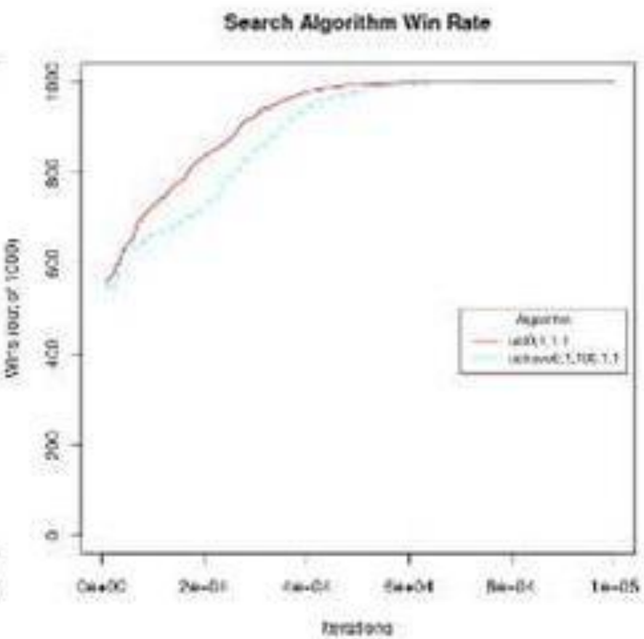
Improvements



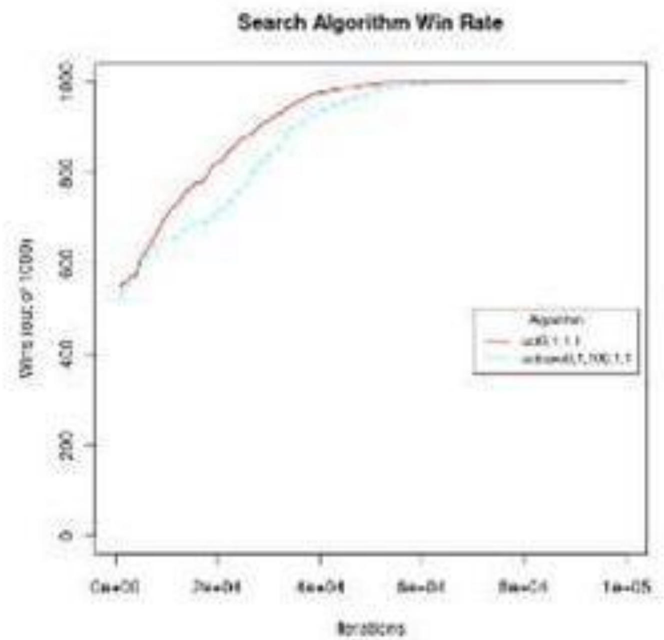
Correlations



No correlation



50% correlation



100% correlation

Conclusions & Future Work

- Improved Gomba testing framework
  - Better support of AMAF algorithms (UCT RAVE)

- Implemented RAVE-Pool in Fuego
  - With Variations

Köszönöm!

Advisors

- Levente Kocsis
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- Stanley Selkow

Daniel Bjorge & John Schaeffer

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All SZTAKI Colleagues

Kérdések?