

From Deep Blue to Monte Carlo: An Update on Game Tree Research



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AAAI-14 Tutorial 6:
State of the art
in specific games.
Wrap-up.

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Image source: ebay.com

Which Method to Choose?

- You want to write a strong program for a new game
- How to approach it?
 - Approach 1: find similar game, follow their approach
 - Approach 2: try all methods, choose best...
 - Approach 3: use a rapid prototyping framework (more on this a bit later)
 - Approach 4: follow the rough guidelines on the next slide
- Remark: in practice, a lot depends on how much time you spend on enhancements, engineering, details

Guidelines – Which Method to Choose for Heuristic Player?

- Evaluation function
 - Do you think you can program a reasonable evaluation function?
 - Yes:
 - Try alphabeta, or MCTS with short playouts
 - No:
 - Try MCTS with full playouts

Guidelines – Which Method to Choose for Solving Game?

- Does your game have early wins, or non-uniform branching factor?
 - Yes:
 - Try PNS
 - No:
 - Try MCTS with solver enhancement

State of the Art in Selected Games

- Chess
- Checkers, Draughts, Othello
- Go
- Japanese chess
- Chinese Chess
- Amazons, Arimaa, Havannah
- Beyond classic board games

Chess

- Method: parallel alphabeta with many enhancements, sophisticated manually designed evaluation function, extensive tuning by play-testing, endgame databases
- Performance: far superior to humans, has beaten strong grandmasters giving pawn handicap
- Top programs: Stockfish (open source), Komodo (commercial), Houdini (commercial)

Checkers

- Method: alphabeta + df-pn + PNS + endgame databases
- Performance: solved as a draw with best play. Top humans can usually draw but lose once in a while
- Top program: Chinook (online play vs limited version)

- Method: parallel retrograde analysis
- Performance: strongly solved, full database computed
- Top program: <http://awari.cs.vu.nl> (currently offline)

Draughts

- 10x10 version of checkers
- Method: alphabeta + endgame databases
- Performance: close to top humans ? Many draws.
- Top programs: ?

Othello

- Method: alphabeta + ProbCut, specialized fast endgame solvers
- Performance: Far above human. Close to perfect?
- Top programs: Saio, Cyrano, Edax
 - Source: http://en.wikipedia.org/wiki/Computer_Othello

- Method: MCTS
- Performance: Strong amateur
- Top programs: Crazy Stone, Zen

Hex

- Method: MCTS + heavy game-specific knowledge
- Performance: solved up to 9x9, mid-level amateur on large boards
- Top programs: MoHex, Wolve (alphabeta-based)

Japanese Chess - Shogi

- Method: alphabeta + df-pn solver + depth-first search solver, large machine-learned evaluation function
- Performance: surpassed top human? No formal match yet.
- Top programs: GPS shogi, Gekisashi, Bonanza + many derivatives, ponanza, Apery

Chinese Chess - Xiangqi

- Method: alphabeta + endgame databases
- Performance: near top human?
- Top programs: Shiga, Chimo, ?

Draughts

- Method: alphabeta + endgame databases
- Performance: close to top human
- Top programs: TDKing, Maximus

Amazons

- Method: MCTS with short playouts (4-5 ply) + evaluation function
- Performance: slightly better than best humans?
- Top programs: Invader, 8QP, Amazong

Clobber

- Method: alphabeta + comb. game-theoretic databases
- Performance: ?
- Top programs: Pan, Mila

Konane, DisKonnnect

- Method: MCTS
- Performance: likely super-human
- Top programs: dkf (Fuego-based)

- Method: MCTS
- Performance: likely superhuman
- Top programs: HappyNoGo

Lines of Action

- Method: MCTS + short playouts + evaluation
- Performance: superhuman
- Top programs: MC-LOA, MIA

Arimaa

- Method: alphabeta, machine-learned move ordering + strong pruning (Wu 2011)
- Performance: 2014 match: 7-2 for humans
- Top programs: Sharp, Ziltoid, Marwin

Havannah

- Method: MCTS + solver
- Performance: strong amateur
- Top programs: Castro, Lajkonik, Wanderer

Poker

- Method: see Poker workshop at AAI 2014
- Performance: see Poker workshop at AAI 2014
- Top programs: see Poker workshop at AAI 2014

Bridge

- Method: Monte Carlo simulation, double dummy solver, bidding rules, ?
- Performance: strong amateur?
- Top programs: Jack, ?

- Method: Perfect Information Monte Carlo, endgame lookup tables, recursive rollouts, partition search, bidding rules
- Performance: super-human?
- Top programs: Recursive Kermit, Kermit
- Link: <http://hdl.handle.net/10402/era.34080>

Your game here...

- Method: ?
- Performance: ?
- Top programs: ?

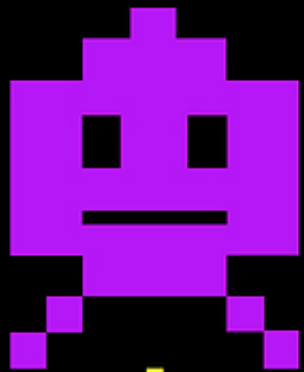
Summary

- Overview of the three current main methods in “classical” two-player board games
 - Alphabeta search
 - Proof-number search
 - Monte Carlo tree search
- Many enhancements for state of the art performance
- How to deal with evaluation
- Parallel search

For More Information

- Follow the references on tutorial homepage
- Specialized Conferences:
 - Computers and Games (CG)
 - Advances in Computer Games (ACG)
 - Computational Intelligence and Games (CIG)
 - Game Programming Workshop in Japan (GPW)
 - Games workshops at IJCAI, AAI,...
- Specialized Journals:
 - IEEE TCIAIG
 - ICGA Journal
- General AI conferences + journals: IJCAI, AAI, AIJ, JAIR,...

GAME OVER



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