

Games Computers Play

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35 Years Ago...

- Computer world chess champion: "soon"
- Widespread agreement on this!
- Other games sure to follow...
- Big lessons about human reasoning!

What Happened?

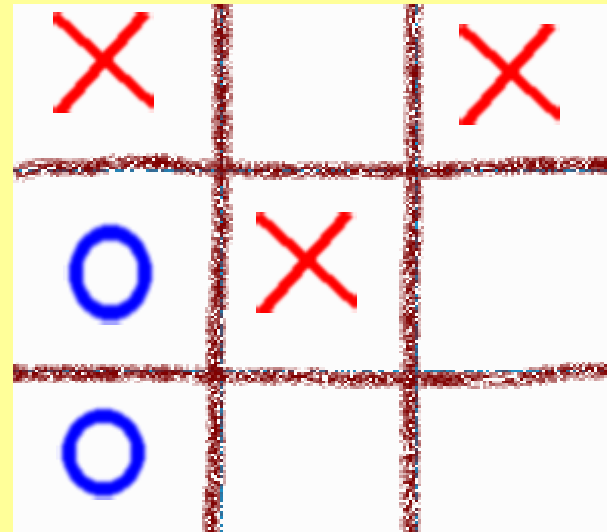
- Human players were underestimated
- Benefits of better computers overestimated
- Clever approach to computer game play!

Overview

- How computers play games
- Survey of computer game play
- Lessons from computer game play

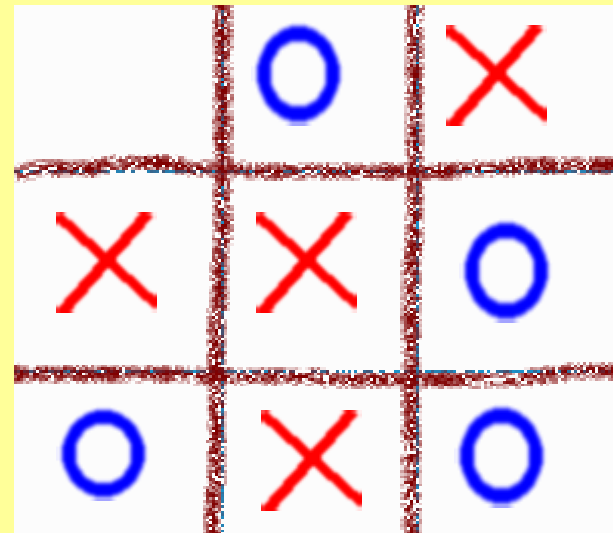
How To Play Tic-Tac-Toe

- Game characteristics:
 - ``zero sum''
 - two player
 - alternating
 - terminating
 - no ``luck''
 - no ``hidden info.''



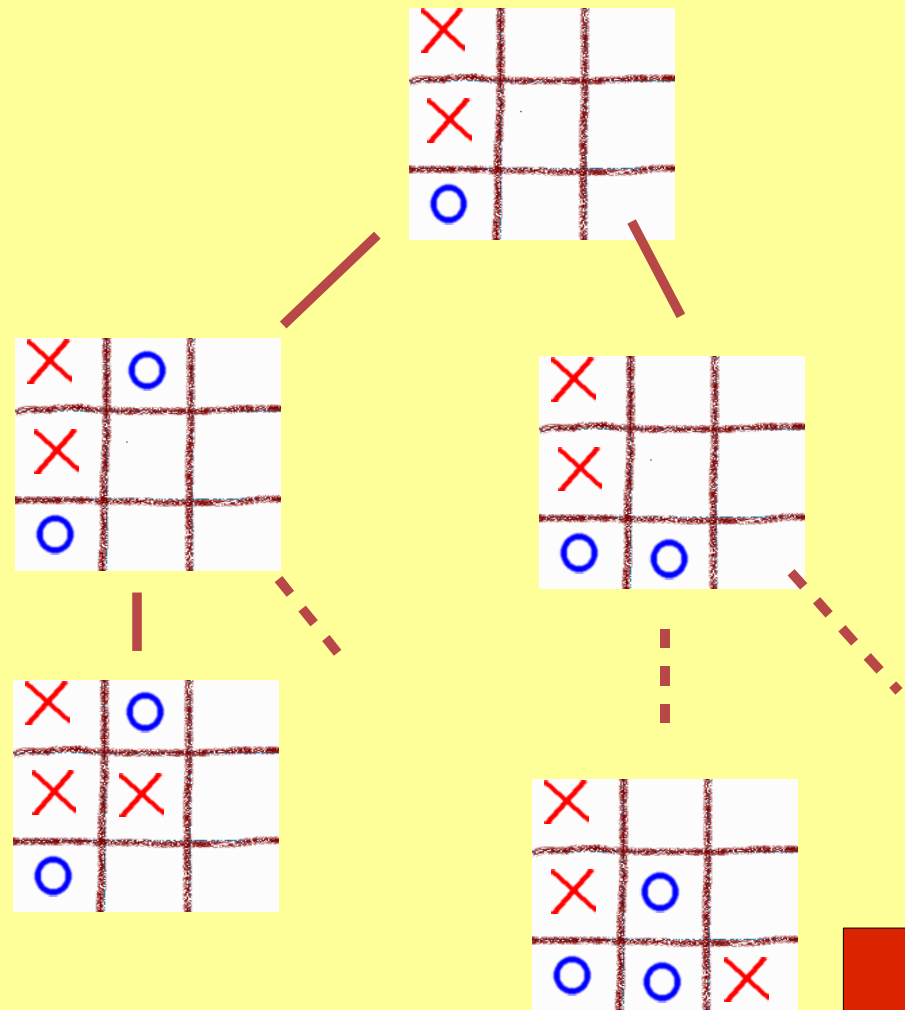
How Humans Play Tic-Tac-Toe

- Identify and block immediate wins
- Set up two-way traps
- Try something new
- Soon learn how to force a draw



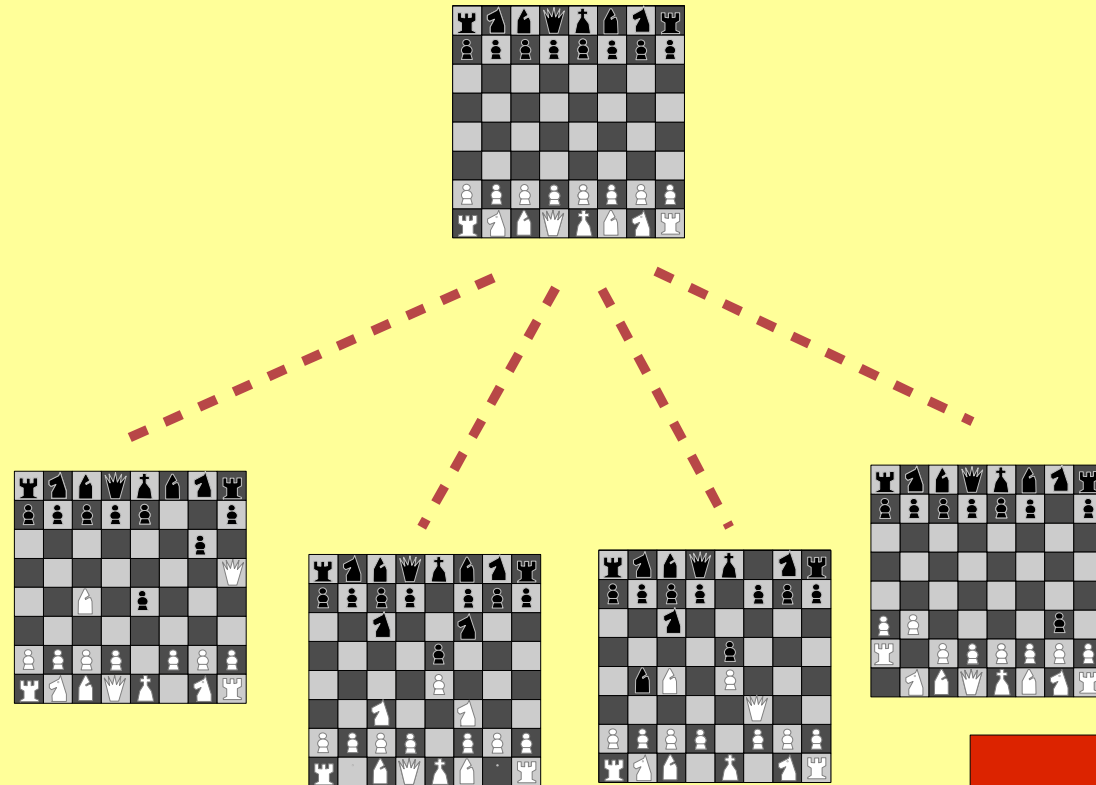
How Computers Play Tic-Tac-Toe

- Game tree search
- Minimize opponent maximum
- Must play every possible game out!



How Computers Play Chess

- Cannot try every possible game
- Play for "a while", then *evaluate*
- In practice, deeper is better
- Opening book, endgame code



How Well Does Search Work?

- Easy to program
- Better for simple games
- Better for faster computers
- Not good enough?
Tough...



Computers Play These Perfectly

- "Solved" games
 - Tic-Tac-Toe
 - 3D 4x4 Tic-Tac-Toe (Qubic), Gomoku, Connect Four
 - Mastermind
 - awari
 - Features
 - Small search
 - regular structure

Checkers

- *Chinook* (Jonathan Schaeffer)
1989 world human-machine
champion, then *Nemesis* (2002)
 - Powerful parallel computer
(very deep search)
 - Retrograde “endgame”
 - "Must-read" book: *One Jump Ahead*
(Springer-Verlag)
- Checkers *solved!!* Schaeffer April 29
2007; it's a draw



Chess

- *Deep Blue* (IBM team) beats Kasparov, February 1997 (3.5-2.5, experts dispute significance)
- *Deep Fritz* draws Kramnik, Oct. 2002 (4-4); *Deep Junior* draws Kasparov, Feb. 2003)
- Kramnik accused of using *Fritz 9* in match against Topalov, September 2006



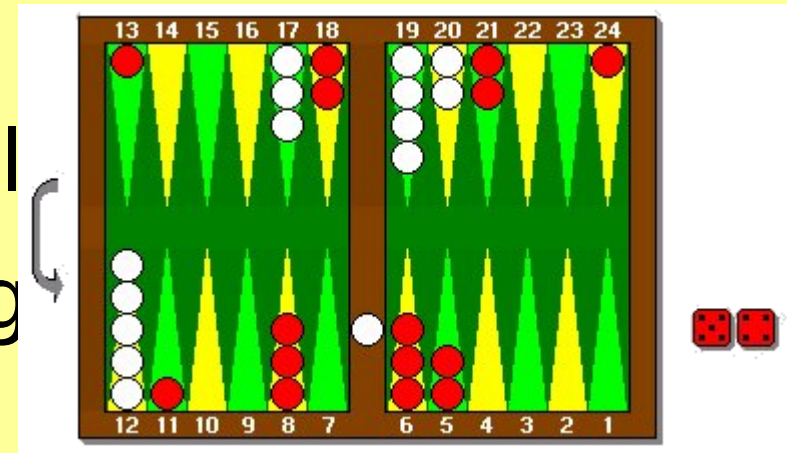
Scrabble

- *Maven* (Brian Sheppard) was roughly par with top human players (e.g. GM Adam Logan), though now stronger
- What does this mean?
 - Top human players know most words
 - More strategy
 - "Luck": randomization (draw) tough for computers



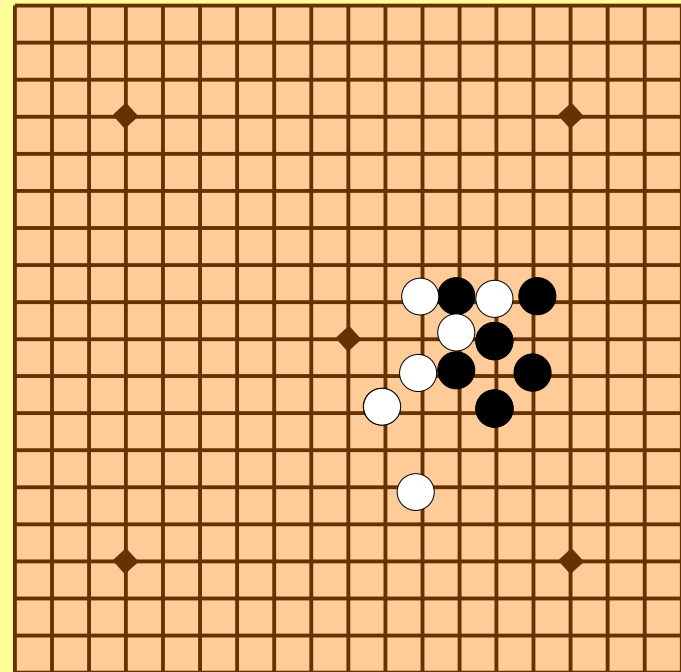
Backgammon

- *TD-Gammon* (Gerald Tesauro, 1990s) roughly par with top human players (e.g. Malcolm Davis)
- Performance near optimal
- Program *learns* by playing (neural nets)
- Handles "luck" (probability) surprisingly well



Go

- Current top programs are worse than 5 kyu?
- 1997: Janice Kim beats *Handtalk* in demo with *25-stone* handicap!
- Go is hard because
 - large branching
 - hard posn eval

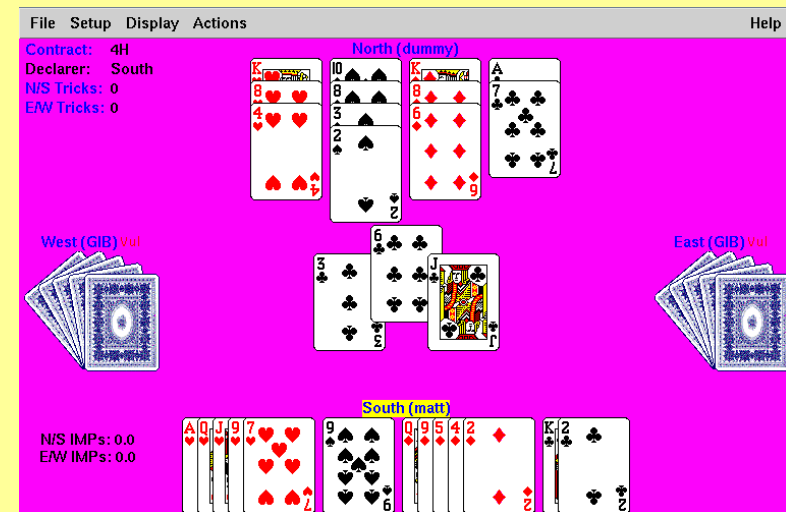


A Giant Leap in Go

- 7 August 2008 – MoGo running on an 800-node Belgian supercomputer cluster defeats US Champion Myungwan Kim...at PSU!
 - 9-stone handicap :-)
 - Maybe 8-stone?
 - Stochastic search breakthrough
 - How will it scale?

Bridge

- Zia Mahmood 1991-1997: £1M bet
- *GIB* (Ginsberg) was world computer champion
- = good club player
 - Bidding so-so
 - Play usually strong
- 2006 programs not way better



How *GIB* Plays Bridge

- Bidding: rules from *Meadowlark* + *Borel Simulation* (guess rest of auction)
- Play: *Monte Carlo* analysis
 - was *double dummy*, but not now
 - Deal, make sure deal consistent with bidding, known cards
 - Run minimax
 - repeat many times

Poker

- Schaeffer *et al* *Polaris vs Phil Laak / Ali Eslami* July 2007
 - Humans win heads-up duplicate match
- Probability, hidden information, multi-player, expectimax: truly challenging
- Big payoffs from online play (fading?)
- Currently quite interesting

The Near Future

- Games of chance (poker, CCGs)
- Hidden information (poker, Stratego)
- Learning

Longer Term

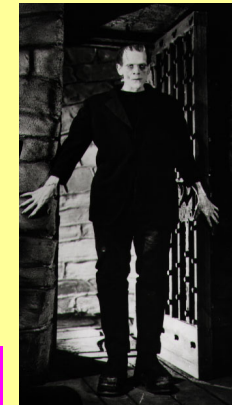
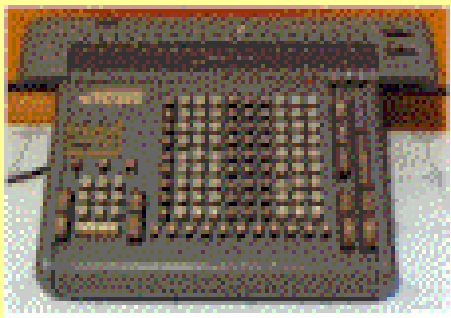
- Multiplayer
- Better strategic play
 - planning
 - pattern recognition
- Not just games any more!
 - military, economic tool
 - general problem solving techniques

AI Lessons From Computer Games

- AI does not scale well with computer size/speed
- Intelligence and game playing ability not *necessarily* related
- "*Pride goes before destruction, and a haughty spirit before a fall.* " —
Proverbs 16:18

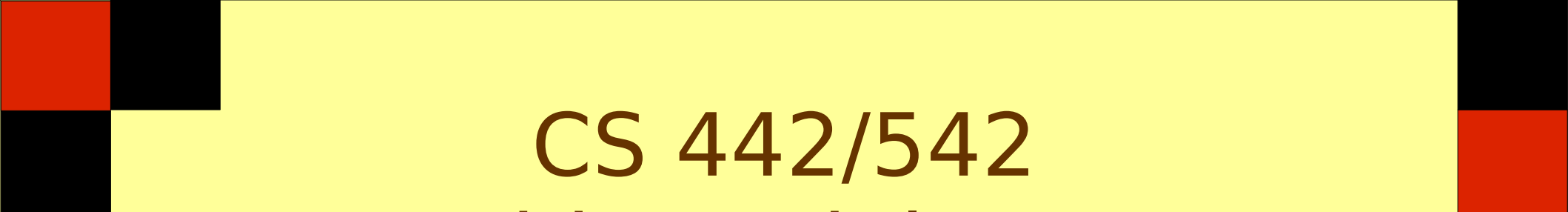
General Lessons From Computer Games

- Old view: John Henry, Frankenstein, R.U.R., HAL, Terminator
- New view: Adding machine
 - Complementary skills
 - Solve *specific* problems



Things To Learn

- Search basics
- Adversary search basics
- Hidden information and probability
- Games-specific tricks and SE
- Theory and formal analysis



CS 442/542

Combinatorial Games

- 10-week version of brief segment on how to build an adversary search engine
 - Optional “funsies” tournament
 - Bring
 - algorithm, data structure clues
 - out-of-class time
 - solid programming skills
 - Spring 2009
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