Game Playing
Part 3 Big Games

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[based on slides from A. Moore http://www.cs.cmu.edu/~awm/tutorials, C. Dyer, J. Skrentny, Jerry Zhu]
Game-playing for large games

• We’ve seen how to find game theoretic values. But it is too expensive for large games.

• What do real chess-playing programs do?
  ▪ They can’t possibly search the full game tree
  ▪ They must respond in limited time
  ▪ They can’t pre-compute a solution
Game-playing for large games

• The most popular solution: heuristic evaluation functions for games
  ▪ ‘Leaves’ are intermediate nodes at a depth cutoff, not terminals
  ▪ Heuristically estimate their values
  ▪ Huge amount of knowledge engineering (R&N 6.4)
  ▪ Example: Tic-Tac-Toe:
    (number of 3-lengths open for me)-(number of 3-lengths open for you)

• Each move is a new depth-cutoff game-tree search (as opposed to search the complete game-tree once).

• Depth-cutoff can increase using iterative deepening, as long as there is time left.
More on large games

• Battle the limited search depth
  ▪ Horizon effect: things can suddenly get much worse just outside your search depth (‘horizon’), but you can’t see that
  ▪ Quiescence / secondary search: select the most ‘interesting’ nodes at the search boundary, expand them further beyond the search depth

• Incorporate book moves
  ▪ Pre-compute / record opening moves, end games
There is an element of chance (coin flip, dice roll, etc.)

“Chance node” in game tree, besides Max and Min nodes. Neither player makes a choice. Instead a random choice is made according to the outcome probabilities.

Two-player zero-sum discrete finite NONdeterministic games of perfect information
Solving non-deterministic games

• Easy to extend minimax to non-deterministic games
• At chance node, instead of using max() or min(), compute the average (weighted by the probabilities).

What’s the value for the chance node at right?
• What action should Max take at root?
• The play will be optimal. In what sense?
What you should know

- What is a two-player zero-sum discrete finite deterministic game of perfect information
- What is a game tree
- What is the minimax value of a game
- Minimax search
- Alpha-beta pruning
- Basic understanding of very large games
- How to extend minimax to non-deterministic games