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:

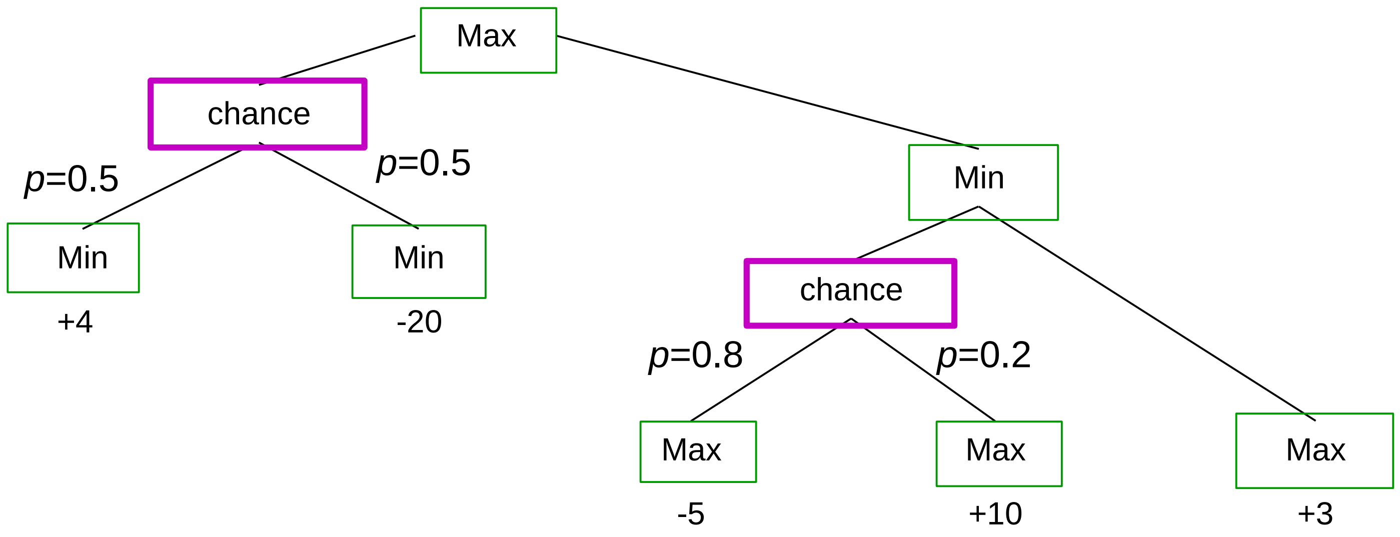
  (number of 3-lengths open for me)-(number of 3-lengths open for you)
- Each move is a new depth-cutoff game-tree search (as opposed to search the complete game-tree once).
- Depth-cutoff can increase using iterative deepening, as long as there is time left.

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

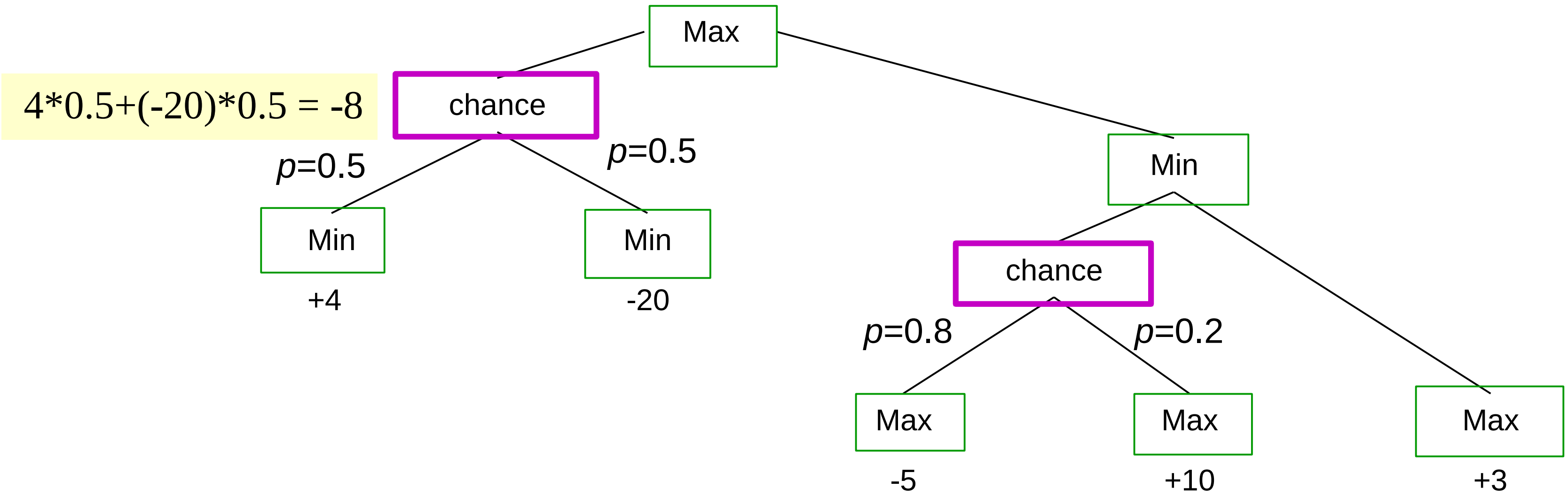
Two-player zero-sum discrete finite NONdeterministic games of perfect information

- 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.



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