Lecture 4: Search in Games
Outline

• Games we are looking at
  o 2-player game
  o Zero-sum game

• The Minimax algorithm

• Alpha-beta pruning

• The Minimax algorithm extends to multiplayer game
Some points

• The Minimax value of a node
  ◦ The utility (for Max) of being in the corresponding state if both players play optimally from there to the end of the game.

• Alpha-beta pruning
  – Alpha: the value of the best choice we have found so far at any choice point along the path for MAX. (i.e. highest-value)
  – Beta: the value of the best choice we have found so far at any choice point along the path for MIN. (i.e. lowest value)
Some points--more

• Evaluation function
  o Needed when building/searching a complete game tree is impossible
  o An estimate of the utility of nodes at the cutoff level
  o Usually a functions of features of the state

• When to cut off
  o Go to fixed depth?
  o Iteratively increase depth until time runs out?
  o Other strategies?
1. Zero-sum means the total payoff of the two players at the end of a game is always zero no matter how the game ends.

2. The Minimax algorithm is optimal because it explores all possibilities and return the Minimax value of the root node.

3. If both players play optimally, other algorithms will not return a better utility of a node than the Minimax algorithm.

4. Time complexity of the Minimax algorithm is $O(b^m)$ because it checks every node in the game tree. ($b$ is the branching factor and $m$ is the maximum depth of leave nodes.)
5. Space complexity of the Minimax algorithm is $O(b^m)$ because it checks every node in the game tree. ($b$ is the branching factor and $m$ is the maximum depth of leave nodes.)

6. The Minimax algorithm can be extended to a multiplayer game as long as it is a zero-sum game.

7. Alpha-beta pruning is optimal because it only cuts off the subtrees that will not affect the Minimax value at the root.

8. Alpha-beta pruning can be extended to multiplayer games and it can significantly reduce the number of nodes searched.
• P1 (first programming assignment) will be released today. It is due on Tuesday Oct. 13th.
  --- due by midnight, upload your files to CS dropbox

• W1 is due on Tuesday Oct. 6th (exactly one week from today)
  --- Due in class, hard copies.