15-381: Artificial Intelligence
Assignment 2: Game Theory and Logic

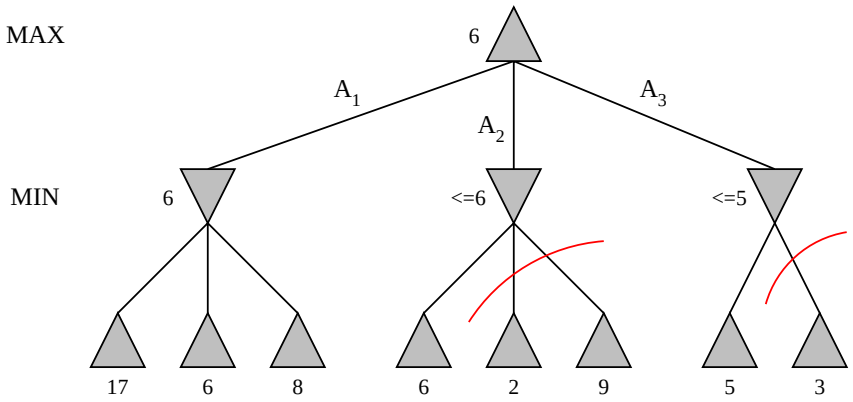
Sample Solution

October 9, 2001

Written Exercises

Excercise 1

(a) For the game tree given below, show which branches would be pruned by alpha-beta and write down all the node values propagated by the algorithm.

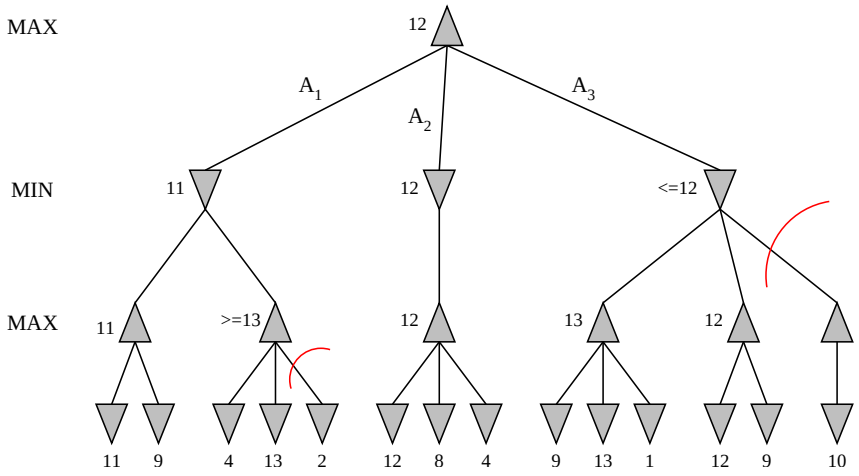


(b) Which action should the MAX player choose?

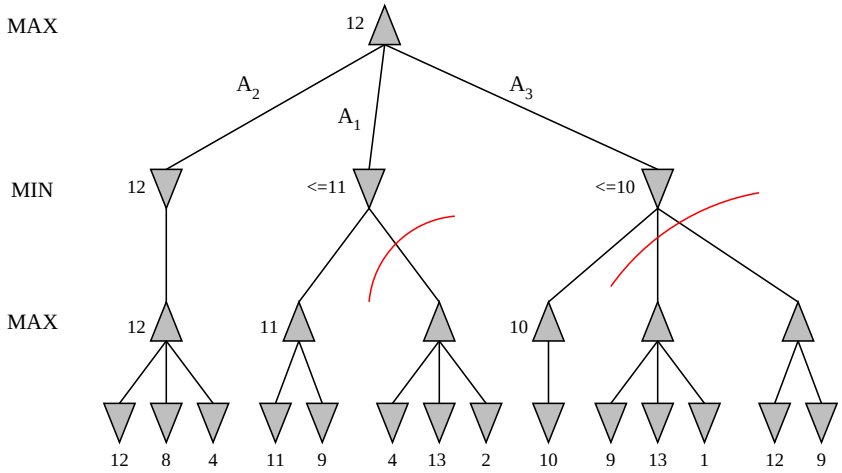
A_1

Exercise 2

(a) For the game tree given below, show which branches would be pruned by alpha-beta and write down all the node values propagated by the algorithm.



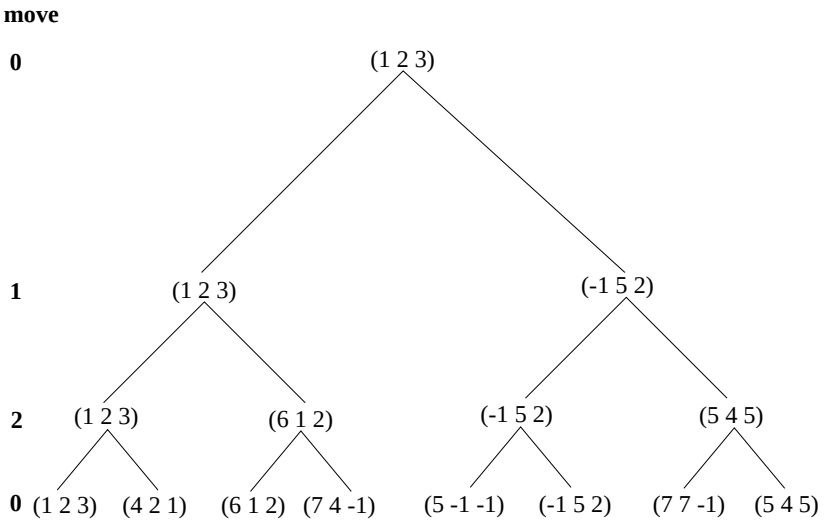
(b) Reorder the children of nodes so that the maximum number of nodes are cut from the tree.



Exercise 3

Do exercise 5.8 on page 147 in *Artificial Intelligence: A Modern Approach*.

(a) Each player maximizes his chance of winning:



(b) By implementing the approach in (a) we get two new versions of the *MiniMax-Decision* and the *Minimax-Value* function. *MiniMax-Decision* still returns an operator, but now it takes an extra argument: the player who is going to make the next move in the current state. *MiniMax-Value* doesn't return a single value any longer but a utility vector with the utility value for all three players. In order to know which player it is maximizing for, it also takes a player as an extra argument.

function MiniMax-Decision(*game*,*player*) **returns** *an operator*
    for each *op* **in** Operators[*game*] **do**
        Vec[*op*] ← MiniMax-Value(Apply(*op*,*game*),game,next(*player*))
    end
    return the *op* with the highest Utility(Vec[*op*],player)

function MiniMax-Value(*state*,*game*,*player*) **returns** *a utility vector*
    if Terminal-Test[*game*](state) **then**
        return UtilityVector[game](state)
    else
        for each *successor* **in** Successor(state) **do**
            Vec[*successor*] ← MiniMax-Value(state(*successor*),*game*),game,next(*player*))
        return Vec[*i*] with highest Utility(Vec[i],player)

(c) We could choose to add the moves *offer*, *accept* and *defect* into the game tree to enable formation and termination of alliances. The utility function would change for players being in an alliance. Suffering short-term losses e.g. to help an ally or breaking ties might have a higher utility at a certain point in the game. Also behaviors like moving towards breaking up with an ally or moving to guard against defection would have to be captured by the utility function.

The utility function would also depend on the history of alliances in the game. If a distrust between two players is built up, they might consider a higher utility of states with a low value of the distrusted player.