Sheet 3 Solutions
Local Search - Minmax Algorithm

1 Local Search

1. Suppose a genetic algorithm uses chromosomes of the form x = abcdefgh with a fixed length of eight genes. Each gene can be any digit between 0 and 9. Let the fitness of individual x be calculated as:
   f (x) = (a + b)(c + d) + (e + f)(g + h)
   and let the initial population consist of four individuals with the following chromosomes:
   x1 = 65413532
   x2 = 87126601
   x3 = 23921285
   x4 = 41852094

   (a) Evaluate the fitness of each individual, and sort them based on their fitness.
   Answer:
   f(x1) = 11 * 5 + 8 * 5 = 95
   f(x2) = 15 * 3 + 12 * 1 = 57
   f(x3) = 5 * 11 + 3 * 13 = 94
   f(x4) = 5 * 13 + 2 * 13 = 91
   Sorting: x1, x3, x4, x2

   (b) Cross the fittest two individuals using one point crossover at the middle point.
   Answer:
   x5 = 65411285, x6 = 23923532

   (c) Cross the second and third fittest individuals using a two points crossover (points b and f).
   Answer:
   x7 = 21852085, x8 = 43921294

   (d) Suppose the new population consists of the four o spring individuals received by the crossover operations in the above question. Evaluate the fitness of the new population, showing all your workings. Has the overall fitness improved?
   Answer:
   f(x5) = 11 * 5 + 3 * 13 = 94
   f(x6) = 5 * 11 + 8 * 5 = 95
   f(x7) = 3 * 13 + 2 * 13 = 65
   f(x8) = 7 * 11 + 3 * 13 = 116
   the overall fitness improved based on relative fitness rank comparison.

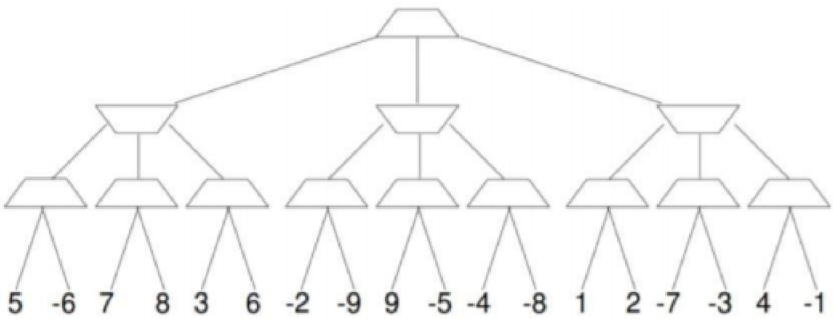
   (e) By looking at the fitness function and considering that genes can only be digits between 0 and 9 find the chromosome representing the optimal solution (i.e. with

the maximum fitness). Find the value of the maximum fitness.
Answer:
best chromosome = 99999999
best fitness = 18 * 18 + 18 * 18 = 648

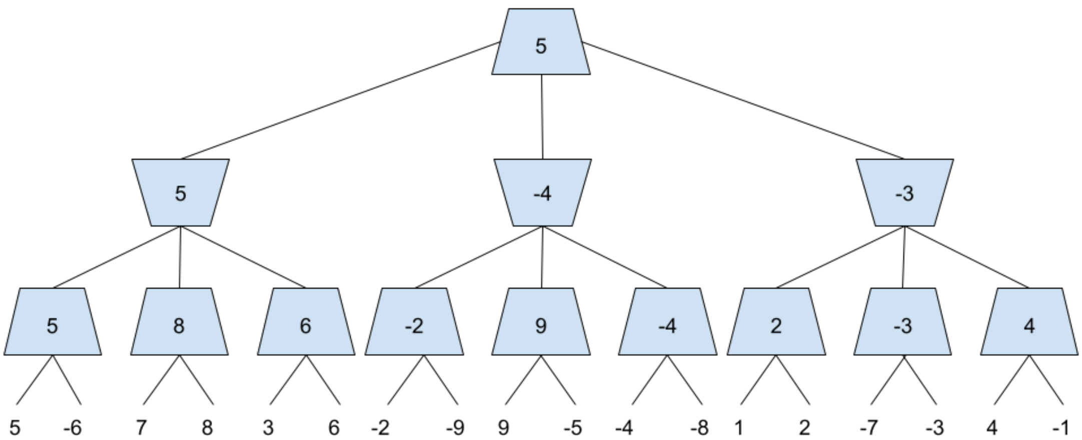
(f) By looking at the initial population of the algorithm can you say whether it will be able to reach the optimal solution without the mutation operator?
Answer:
No, because there is places that doesn't contain 9 at any of the initial parents.

2 Minmax Algorithm

1. Consider the game tree shown in the following figure, the static scores are at the leave nodes. Trapezoids that point up, such as at the root, represent choices for the maximizer; trapezoids that point down represent choices for the minimizer.

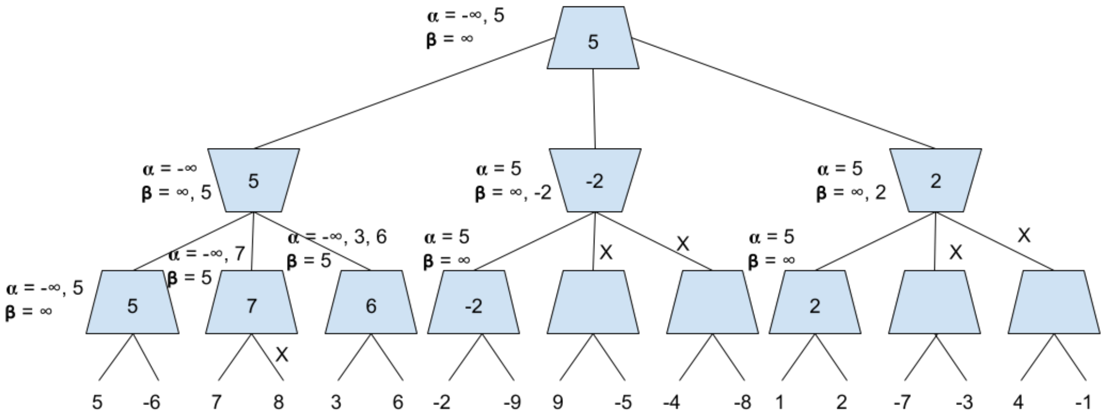


(a) Apply Minmax to show what move the first player should choose.
Answer:



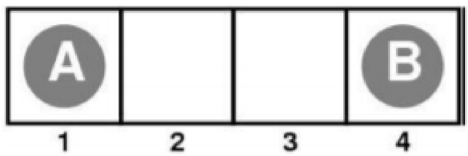
take first move.

(b) Use alpha-beta pruning to show what nodes needn't be examined. Assume that the nodes are examined from left-to-right.
Answer:



take first move.

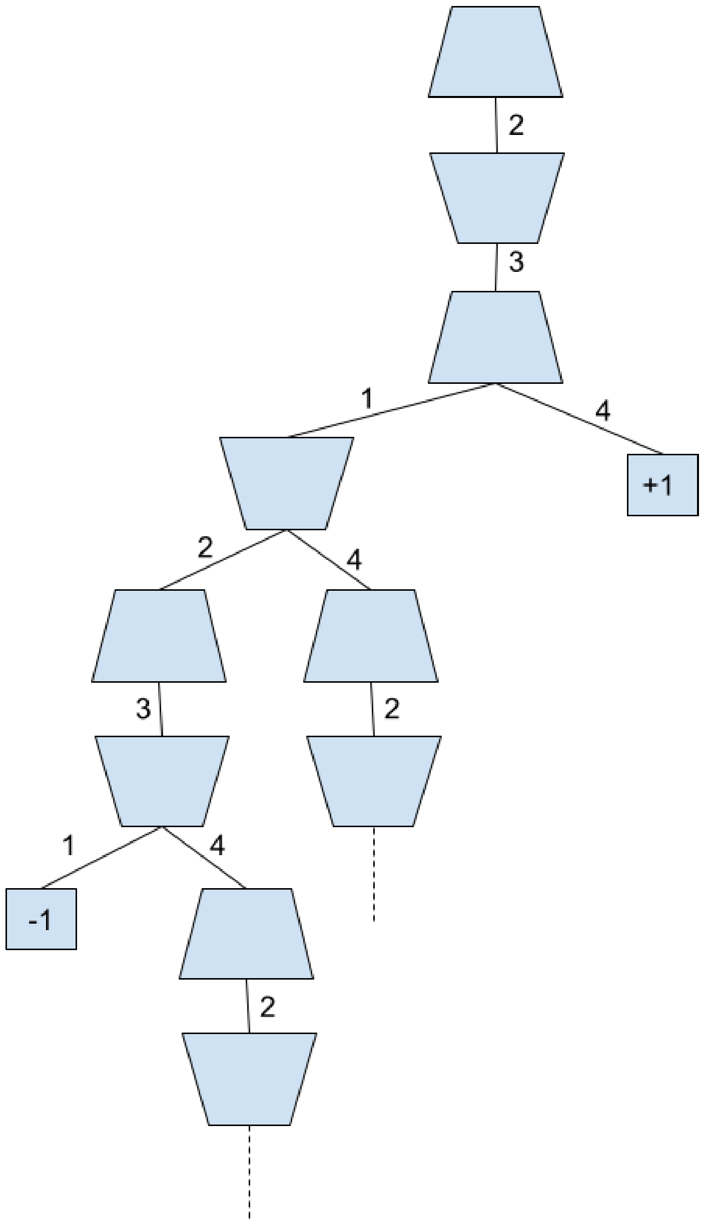
2. Consider the two-player game described in the following figure



The figure shows the starting position of a simple game. Use the following conventions:

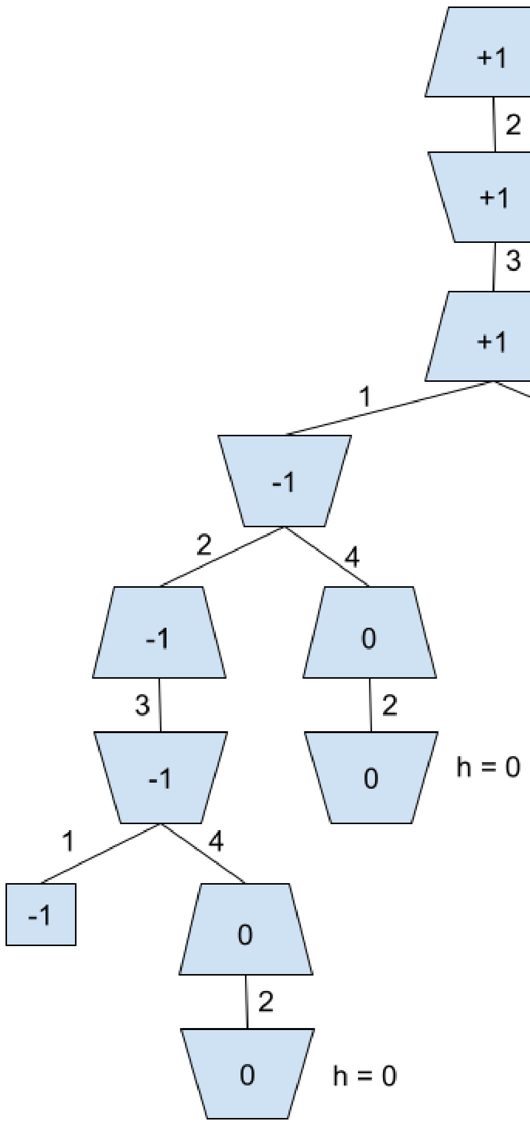
- Player A moves First.
- The two players take turns moving, and each player must move his token to an open adjacent space in either direction.
- If the opponent occupies an adjacent space, then a player may jump over the opponent to the next open space if any (for example, if A is on 3 and B is on 2, then A may move back to 1).
- The game ends when one player reaches the opposite end of the board.
- If player A reaches space 4 First, then the value of the game to A is +1; if player B reaches space 1 First, then the value of the game to A is -1.

(a) Draw the complete game tree of the above problem and put each terminal state in a square box and write it's game value in a circle next to it.
Answer:



all moves after level 7 are redundant as they repeat the same tree so we will prune them returning 0.

(b) Apply the minmax playing algorithm.
Answer:



A can win easily by moving to 2, B move to 3, then A move to 4.

Good Luck