

Solutions to Problem 1 of Homework 3 (3 Points)

*Name: Anav Prasad (ap7152)**Due: 5PM on Monday, February 14**Collaborators:*

Assuming the root player is max, using variables as shown in class, write out the minimax solution for this tree; e.g. $x1 = \max(2, -19, 8)$; $b = \min(b1, b2, b3)$; etc

Solution:

The minimax solution for the given tree (assuming the root player is max) would go as follows:

$$\text{root} = \max(b, c, d) = \max(8, 13, 15) = 15$$

$$b = \min(b1, b2, b3) = \min(8, 15, 14) = 8$$

$$b1 = \max(b1a, b1b, b1c) = \max(2, -19, 8) = 8$$

$$b2 = \max(b2a, b2b, b2c) = \max(11, 15, -8) = 15$$

$$b3 = \max(b3a, b3b, b3c) = \max(13, 3, 14) = 14$$

$$c = \min(c1, c2, c3) = \min(13, 15, 27) = 13$$

$$c1 = \max(c1a, c1b, c1c) = \max(8, 13, -2) = 13$$

$$c2 = \max(c2a, c2b, c2c) = \max(-7, 15, -28) = 15$$

$$c3 = \max(c3a, c3b, c3c) = \max(-10, 27, 10) = 27$$

$$d = \min(d1, d2, d3) = \min(15, 23, 26) = 15$$

$$d1 = \max(d1a, d1b, d1c) = \max(-19, -5, 15) = 15$$

$$d2 = \max(d2a, d2b, d2c) = \max(-20, 22, 23) = 23$$

$$d3 = \max(d3a, d3b, d3c) = \max(-12, 26, -2) = 26$$

Thus, the minimax solution for the given tree is 15 for the root max player. □

Solutions to Problem 2 of Homework 3 (2 Points)

Name: Anav Prasad (ap7152)

Due: 5PM on Monday, February 14

Collaborators:

Which branch should the max player take from root?

Solution:

The max player should take the `d` branch from the `root` because the score for the max player is maximized in that branch (i.e. 15). ☐

Solutions to Problem 3 of Homework 3 (2 Points)

Name: Anav Prasad (ap7152)

Due: 5PM on Monday, February 14

Collaborators:

Which branch should the min player take from root?

Solution:

To figure out the min player's branch from root, let's consider the minimax solution for the given tree first assuming that the root player is now *min*.

$$\text{root} = \min(b, c, d) = \min(3, -2, -12) = -12$$

$$b = \max(b1, b2, b3) = \max(-19, -8, 3) = 3$$

$$b1 = \min(b1a, b1b, b1c) = \min(2, -19, 8) = -19$$

$$b2 = \min(b2a, b2b, b2c) = \min(11, 15, -8) = -8$$

$$b3 = \min(b3a, b3b, b3c) = \min(13, 3, 14) = 3$$

$$c = \max(c1, c2, c3) = \max(-2, -28, -10) = -2$$

$$c1 = \min(c1a, c1b, c1c) = \min(8, 13, -2) = -2$$

$$c2 = \min(c2a, c2b, c2c) = \min(-7, 15, -28) = -28$$

$$c3 = \min(c3a, c3b, c3c) = \min(-10, 27, 10) = -10$$

$$d = \max(d1, d2, d3) = \max(-19, -20, -12) = -12$$

$$d1 = \min(d1a, d1b, d1c) = \min(-19, -5, 15) = -19$$

$$d2 = \min(d2a, d2b, d2c) = \min(-20, 22, 23) = -20$$

$$d3 = \min(d3a, d3b, d3c) = \min(-12, 26, -2) = -12$$

So, on the basis of the values obtained before, the min player at **root** should take the **d** branch since that has the least score (-12). □

Solutions to Problem 4 of Homework 3 (3 Points)

*Name: Anav Prasad (ap7152)**Due: 5PM on Monday, February 14**Collaborators:*

Assuming the root player is max, using alpha-beta pruning which nodes will be pruned. This includes nodes partially visited but then pruned. Just a list, order does not matter.

Solution: To figure out the list of nodes that will be pruned by the Alpha-beta pruning algorithm, let's first consider the solution obtained from the said algorithm below.

$\text{root} = \max(b, c, d) = \max(8, 13, 15) = 15$

$\alpha = \text{Not defined yet}$

$\beta = \text{Not defined yet}$

$b = \min(b_1, b_2, b_3) = \min(8, _, _) = 8$

$\alpha = \text{Not defined yet}$

$\beta = \text{Not defined yet}$

$b_1 = \max(b_{1a}, b_{1b}, b_{1c}) = \max(2, -19, 8) = 8$

$\alpha = \text{Not defined yet}$

$\beta = 8$

$b_2 = \max(b_{2a}, b_{2b}, b_{2c}) = \max(11, _, _) = \text{prune (because } 11 > \beta)$

$\alpha = \text{Not defined yet}$

$\beta = 8$

$b_3 = \max(b_{3a}, b_{3b}, b_{3c}) = \max(13, _, _) = \text{prune (because } 13 > \beta)$

$\alpha = 8$

$\beta = \text{Not defined yet}$

$c = \min(c_1, c_2, c_3) = \min(13, _, _) = 13$

$\alpha = 8$

$\beta = \text{Not defined yet}$

$c_1 = \max(c_{1a}, c_{1b}, c_{1c}) = \max(8, 13, -2) = 13$

$\alpha = 8$

beta = 13

c2 = max(c2a, c2b, c2c) = max(-7, 15, _) = prune (because 15 > beta)

alpha = 8

beta = 13

c3 = max(c3a, c3b, c3c) = max(-10, 27, _) = prune (because 27 > beta)

alpha = 13

beta = Not defined yet

d = min(d1, d2, d3) = min(15, _, _) = 15

alpha = 13

beta = Not defined yet

d1 = max(d1a, d1b, d1c) = max(-19, -5, 15) = 15

alpha = 13

beta = 15

d2 = max(d2a, d2b, d2c) = max(-20, 22, _) = prune (because 22 > beta)

alpha = 13

beta = 15

d3 = max(d3a, d3b, d3c) = max(-12, 26, _) = prune (because 26 > beta)

So, the nodes that were pruned, as seen above, were the following:

-> b2

-> b2b

-> b2c

-> b3

-> b3b

-> b3c

-> c2

-> c2c

-> c3

-> c3c

-> d2

-> d2c

-> d3

-> d3c

□