COMS 4701 - Homework 3 - Conceptual

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Question 1

Following statements are true about adversarial search:

1. In zero-sum games with two players, one agent maximizes one single value, while the other minimizes it.
2. We can't always search the leaves in game trees because we may be limited in time.
3. Both Alpha and Beta are sent down the tree
4. Alpha is the current lower bound on MAX's outcome and Beta is the current upper bound on MIN's outcome.

Question 2

(a) What is the value of Max at the root?
Answer: 2

(b)
1. Initialization:
   - Assign $\alpha = -\infty, \beta = \infty$
   - At Max Nodes: $\alpha = max(\alpha_{current}, value_{current})$
   - At Min Nodes: $\beta = min(\beta_{current}, value_{current})$
2. Pruning: When $\beta \leq \alpha$ Prune the the remaining branches
3. Steps:
   - After step 'g', $\alpha = max(-\infty, 2) = 2$
   - At the node with 'g' and 'h' as branches, $\beta = \infty$. Hence $\beta \leq \alpha$ is false. Hence we continue exploring the right child.
   - The value after exploring 'g' and 'h' at that node is $max(2, -17) = 2$. 'c' passes value 2 to the node above it.
   - At the node with 'c' and 'd' as branches, $\beta = min(\infty, 2) = 2$. This $\beta = 2$ is propagated down.
   - After 'd', after exploring the left node 'i', $\alpha = max(-\infty, 15) = 15$. And $\beta = 2$. Hence $\beta \leq \alpha$ is true. No need to explore the right child branch 'j'.
     Intuition: Minimizer above 'c' and 'd' already know that a value of 2 is possible and it will never choose anything from 'd' as soon as it sees 15. So no matter what value is possible after 'i', it doesn't matter for finding optimal solution.
     Hence branch 'j' is cut.
   - The node after 'd' gets the value 15. At above 'c' and 'd', $\beta = min(2, 15) = 2$
   - At the root node, $\alpha = 2$. And this $\alpha = 2$ propagated down to all the nodes of the right side sub-tree of the root node.
   - The node after 'e' gets the value -12 after exploring the branch 'k'. $\alpha = max(-12, 2) = 2$ and $\beta = \infty$. Hence $\beta \leq \alpha$ is false. We explore the right child via branch 'l'.
   - The node after branch 'e' gets the value -11. Hence for the node above 'e' and 'f' branches, $\beta = min(\infty, -11) = -11$. And $\alpha = 2$.
   - Hence at the node after branch 'b', we have $\beta = -11$. And $\alpha = 2$. Hence ence $\beta \leq \alpha$ is True.
   - No need to explore the right of the node, i.e branch 'f' is cut.
     Intuition: Minimizer above 'e' and 'f' already know that a value of -11 is possible and the root node Maximizer knows that value of 2 is achievable. So no matter what value is possible after 'f', the maximizer will never choose -11 and get any value less than 2.
     Hence branch 'f' is cut.
3. Branches which are cut:
   - Branch 'j'
     Justification: Minimizer above 'c' and 'd' already know that a value of 2 is possible and it will never choose anything from 'd' as soon as it sees 15. So no matter what value is possible after 'i', it doesn't matter for finding optimal solution.
     Hence branch 'j' is cut.
   - Branch 'f' (Hence the following branches 'm' and 'n' also cut along with 'f')
     Justification: Minimizer above 'e' and 'f' already know that a value of -11 is possible and the root node Maximizer knows that value of 2 is achievable. So no matter what value is possible after 'f', the maximizer will never choose -11 and get any value less than 2.
     Hence branch 'f' is cut. And the branches 'm' and 'n' also cut along with 'f'

Question 3

1. $HEADS \rightarrow IWIN$
   $TAILS \rightarrow YOULOSE$
2. $HEADS \vee TAILS \equiv TRUE$
   $YOULOSE \rightarrow IWIN$
   $IWIN \rightarrow YOULOSE$
   Now the total KB is:
   - $HEADS \rightarrow IWIN$
   - $TAILS \rightarrow YOULOSE$
   - $HEADS \vee TAILS \equiv TRUE$
   - $YOULOSE \rightarrow IWIN$
   - $IWIN \rightarrow YOULOSE$
3. Writing in disjunctive clause:
   a. $\neg HEADS \vee IWIN$
   b. $\neg TAILS \vee YOULOSE$
   c. $HEADS \vee TAILS$
   d. $\neg YOULOSE \vee IWIN$
   e. $\neg IWIN \vee YOULOSE$
4. Resolution to prove the goal sentence $IWIN$ using Disjunctive syllogism.
   Answer:
   Start with $\neg IWIN$ Using disjunctive clause
   1. Given : $\neg IWIN$,
      disjunctive clause (a): $\neg HEADS \vee IWIN$ Result: $\neg HEADS$
   2. Given : $\neg HEADS$,
      disjunctive clause (c): $HEADS \vee TAILS$ Result: $TAILS$
   3. Given : $TAILS$,
      disjunctive clause (b): $\neg TAILS \vee YOULOSE$ Result: $YOULOSE$
   4. Given : $YOULOSE$,
      disjunctive clause (d): $\neg YOULOSE \vee IWIN$ Result: $IWIN$

   We started with $\neg IWIN$ and result is $IWIN$ which is false. Hence proved.

Question 4

(a.) The 5 nearest neighbors of example M are: H, L, N, R, G

(b.) G, H, L are positive, and N, R are negative. Hence class of M is positive.

(c.) **Consequences:**

1. Mass of each point will influence the classification heavily if we don't handle it properly. For e.g. classification can get heavily influenced by the large mass of opposite class which is far away.
2. If standard deviation is very large, there will be some points with mass which is quite larger than mean. In that case, features x_1, x_2 will be not play important role and classification will be heavily polarized by mass only.

Solution:

1. We can use Z-score Normalization on Mass feature using $\mu = \sum_{i=A}^{Y} mass_i$
   and given standard $stdev_m = 100$ deviation.
   $newmass_i = \frac{mass_i - \mu}{stdev_m}$
2. We can also use Weighted k-NN. So that the influence of large mass far away is minimized.