CSE573 - Writing Assignment 1

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Problem 1

(A) This method is complete because at each iteration the agent's height will increase, so it must eventually reach the peak. However, this algorithm is not optimal because if there are multiple paths to the peak we cannot guarantee it takes the shortest one. We could improve this by taking the next step with the largest height gain.

(B)

a. The simplest state space representation would be a sequence of positions, ie. $\{(x_0, y_0), (x_1, y_1), \ldots, (x_n, y_n)\}$.

b. In this case, one only needs to store which corners have been visited, as well as the current position: $\{\{cornersvisited\}, (x, y)\}$.

(C) In one circumstance, if the heuristic is perfect (ie. the heuristic equals exactly the optimal cost to the goal) then greedy will likely expand fewer nodes than uniform cost search. Another circumstance in which greedy search is better is if the optimal path still has high cost, whereas there are many paths with low cost that do not reach the goal. These will all be explored before finding the path to the goal.

(D)

a. $x = y = z = w = 1$. Both paths are optimal so they will both find the optimal path.

b. $x = 15$, $y = 1$, $z = 1$, $w = 1$. In this case, the optimal path is $S - B - G$ with total cost 2. Greedy will return $S - A - G$ since $h(A)$ is lower than $h(B)$. But A^* will go to B first since $h(B) + c(z : S \to B) = 15 + 1 = 16$ whereas $h(A) + c(x : S \to A) = 2 + 15 = 17$.

Problem 2 *(A)*

Algorithm	A-B-D-G	A-C-D-G	A-C-D-E-G
BFS	X	X	
DFS	X	X	X
UCS			X
Greedy h1		X	
Greedy h2		X	
A^* h1			X
A^* h2			X

(B) The optimal cost is $g = 11$ with the optimal path being A-C-D-E-G.

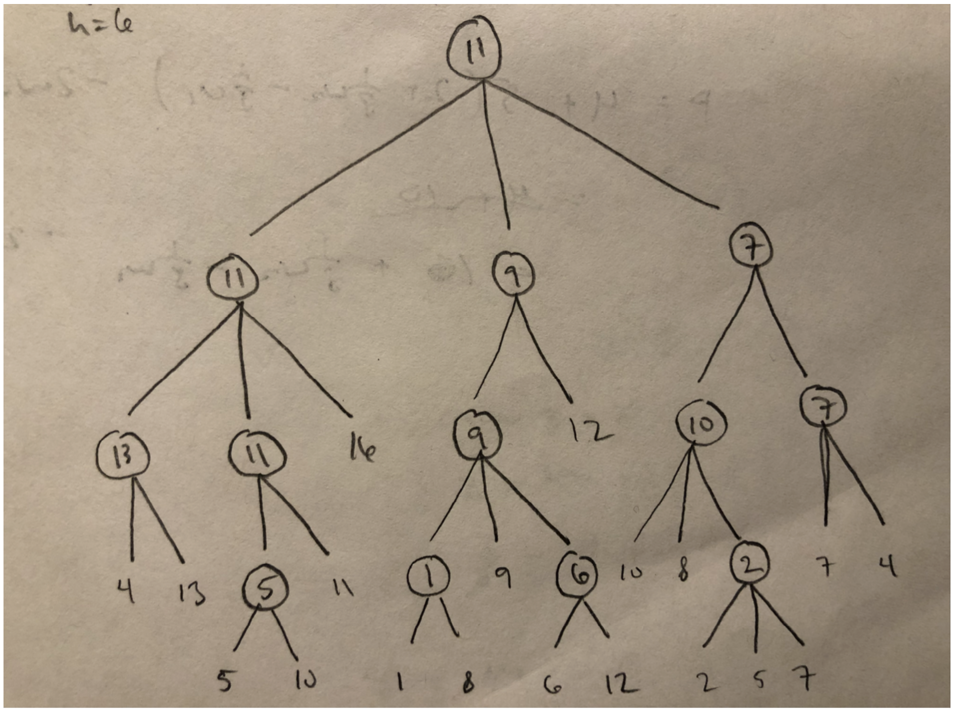
(C) The heuristic h_1 is not admissible because, for instance, the cost from A is $g = 11$ (answer from (B)), but the $h_1(A) = 12.5$. It is not consistent either since $h_1(B) - h_1(D) = 7$ but the cost between them is 5.

(D) h_2 is admissible and consistent.

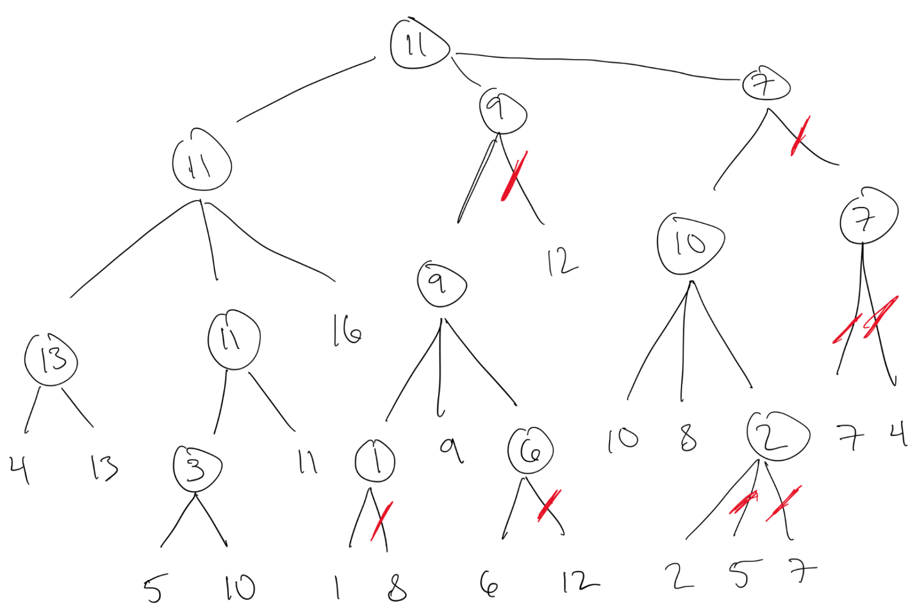
(E) If a heuristic is admissible and consistent, then A^* will return the optimal solution. Since greedy does not necessarily return the optimal solution, it will always be at least as expensive as the A^* solution.

Problem 3

(A)



(B)



(C) No, the end values will be the same for each algorithm.

Problem 4

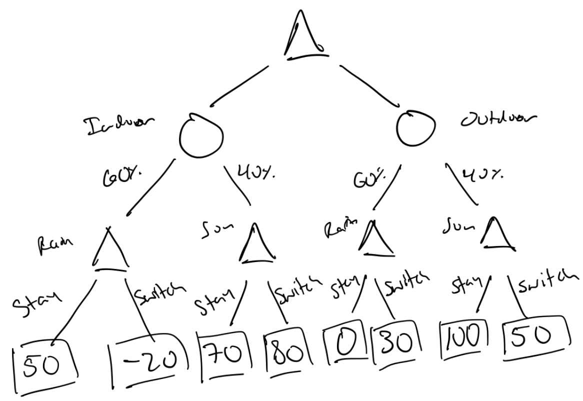
(A) This is not practical because there are $n!$ possible games. In order to create a good evaluation function, we could consider some features of the game state such as the smallest number of markers that would need to be placed in order to create an end-to-end chain for both us and the opponent (or whether it is possible at all).

(B) One evaluation function we could use is the minimal number of markers needed to create a winning path, with a state with no possible winning paths getting a score of ∞. Then, it intuitively seems like a state closer to winning would have a better evaluation function. This could be implemented by iteratively adding in adjacent positions to the player's current set of tiles until there exists a path from end to end. The evaluation function would then return the number of iterations performed.

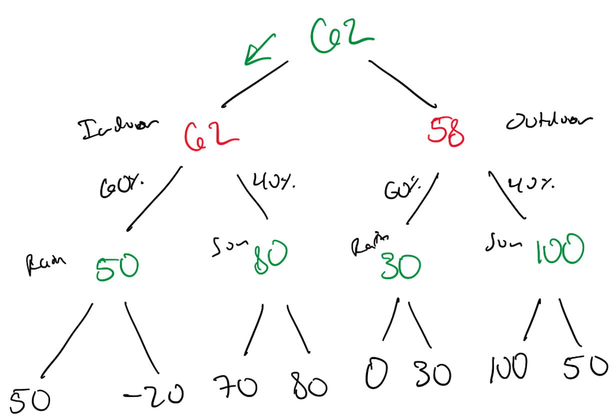
(C) Since there are n^2 possible initial actions, then for the second move there will be $n^2 - 1$ possible actions and for the third $n^2 - 2$. Thus, the agent will have to consider $n^2(n^2 - 1)(n^2 - 2)$ actions which is on the order of $O(n^6)$.

Problem 5

(A)



(B) In this case we see that our utility is on expectation maximized if we choose to sit indoors.

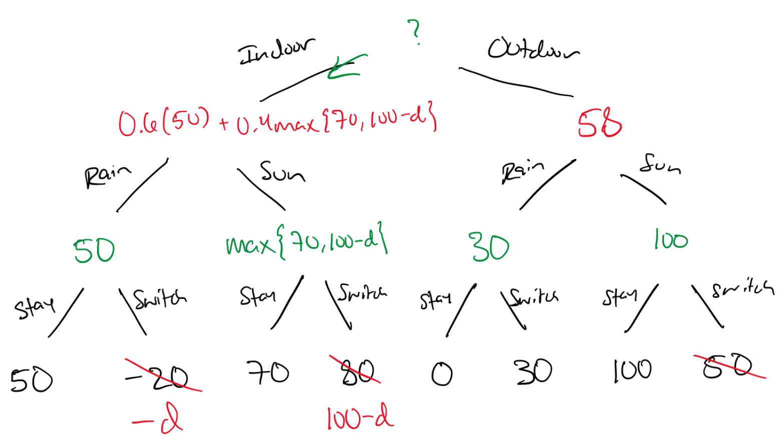


(C) If the probability of rain is p, the expected value when we choose to sit indoor will be $50p + 80(1 - p)$ and when we choose outdoor the expected value is $30p + 100(1 - p)$. Solving for p in

$$50p + 80(1 - p) = 30p + 100(1 - p),$$

we find that the utilities are equal when $p = 1/2$. Graphing the utility functions, we find that we should choose the patio when $p < 1/2$ and choose indoor seating when $p > 1/2$.

(D) Below is the tree corresponding to a deduction of d due to switching at the last moment.



We see that a difference in the tree will only occur when $d < 30$ versus when $d > 30$, and that the the expected utility is still 58 if we initially choose the patio. If $d < 30$, the expected value of sitting indoors is $0.6(50) + 0.4(100 - d)$. In this range of $0 < d < 30$, we see that $0.6(50) + 0.4(100 - d) > 58$ so we should choose indoor seating. When $d > 30$, the expected utility of sitting indoors is $0.6(50) + 0.4(70) = 58$, so in this case the expected utilities are the same.

(E) We see that if Pacman plays as if the ghost is adversarial (ie. Pacman uses minimax), then the utility will be average. On the other hand, if Pacman plays as if the ghost is random (expectimax), then Pacman is penalized if the ghost turns out to be adversarial, but is, on expectation, rewarded if the ghost is in fact random.

A=3		Adversarial	Random
	Minimax	-3	-3
	Expectimax	-4	-2

A=100		Adversarial	Random
	Minimax	-3	-3
	Expectimax	-4	48.5

(F) We have the following search tree below. In the ghosts turn, it will move clockwise with probability $P(\text{ghost is adversarial}) + (P(\text{ghost is random})/2) = 1 - \alpha + \alpha/2 = 1 - \alpha/2$ and will move counterclockwise with probability $\alpha/2$. Since $A \geq 0$, $A - 3 \geq -5$ so the expected utility if Pacman moves counterclockwise is

$$(1 - \alpha/2)(-4) + \alpha(A - 3) = \frac{\alpha}{2}\Big(A + 1\Big) - 4.$$

Therefore we conclude that Pacman should move clockwise if $\frac{\alpha}{2}\Big(A + 1\Big) - 4 < -3$ and should move counterclockwise otherwise.