COMP6721 Applied Artificial Intelligence (Summer 2023)
Assignment #1 (5% of the final grade)

Submission Deadline: Sunday June 4th, 11:59 PM (PDF on Moodle)

No need to prepare your submission using a text processor (Word, Latex). Take legible photos of your handwritten solutions, make it one PDF file, and submit it to Moodle. Thank you!

Question	Subject	Points
Q1	Time Machine (AI History)	3
Q2	Prince looking for Cinderella (Search)	15
Q3	Game (Adversarial)	15
Q4	Where to find your friend (Naïve Bayes)	15
Q5	(Decision Tree)	15
Q6	Informed search	6
Q7	Our version of Tic-Tac-Tao	6

Grades: 50 + 25 Bonus [75]

Question 1) [3p] Time Machine

Assume, thanks to a time machine, you have the chance to visit Montreal Expo 1967, with all the knowledge and expertise that you have right now and what you've studied in COMP 6721 so far. After the visit, you decide to meet AI experts of the time (1967) and inform them of an AI winter that may arrive soon and suggest solutions to prevent it.

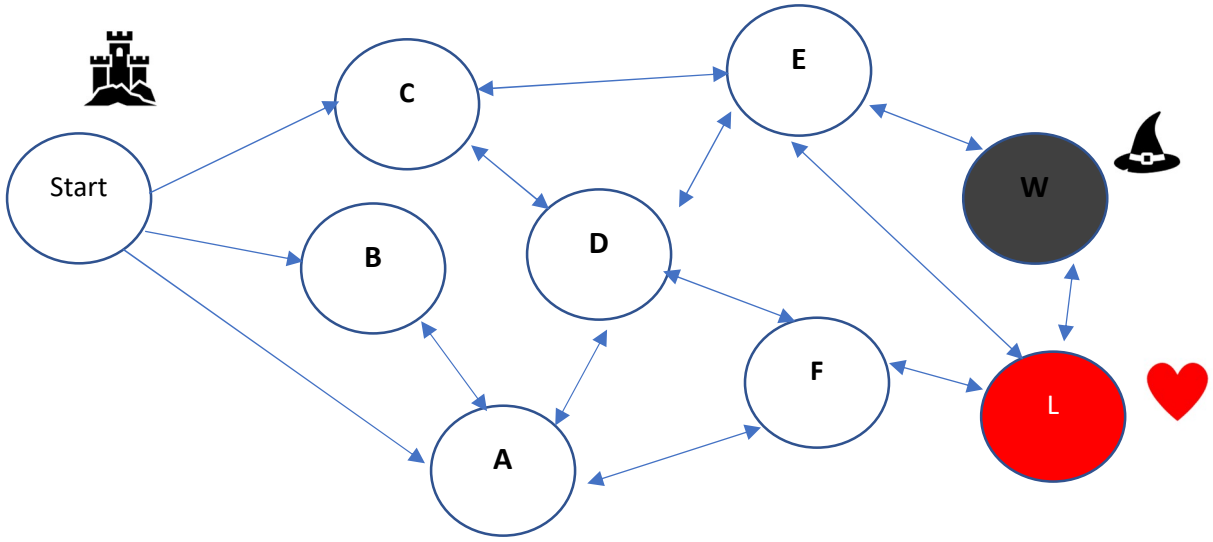
a) What would you suggest? How could you help preventing the first AI Winter?

b) In addition, select an AI technique or an algorithm of your choice that was relatively unknown at that epoch but has since gained substantial importance in recent years and simply explain it to the experts.

Question 2) Prince looking for Cinderella

Cinderella left the ceremony in hurry just before midnight and lost her shoe there! Now, the broken-hearted prince plans to visit all houses of the town looking for the first "perfect fit". You design a search agent to help the prince.

This is the graph of the town where nodes indicate the houses, and edges represent the only available routes between two houses. Cinderella lives in house L (Love) (the goal state).



<u>In equal conditions, the Prince visits houses in alphabetical order (A-Z).</u>

Simple search

Assume that House W is empty, and the Witch is not home. Discuss and reason (write the steps for each algorithm) if the following statements are Ture.

(i) [4 pts] BFS Search expands (nodes placed in the closed list) more nodes than DFS Search
(ii) [1 pt] DFS Search can find a path to Cinderella's house
(iii) [1 pt] DFS Search <u>finds the shortest path</u> to Cinderella's house
(iv) [3 pts] Depth-limited search with depth=3 can find a path to Cinderella's house
(v) [4 pts] Uniform cost Search (UCS) <u>finds the shortest path</u> to Cinderella's house

Now assume that the Witch is back to her house (W) and she can change herself into a young lady, and Golden Shoe will fit her too (If Prince visits W before L, the story will also end but in sadness).

(vi) [1 pt] With DFS Search, Prince can reach Cinderella before the Witch
(vii) [1 pt] With BFS Search, Prince can reach Cinderella before the Witch

Question 3 Game

Consider this game tree.

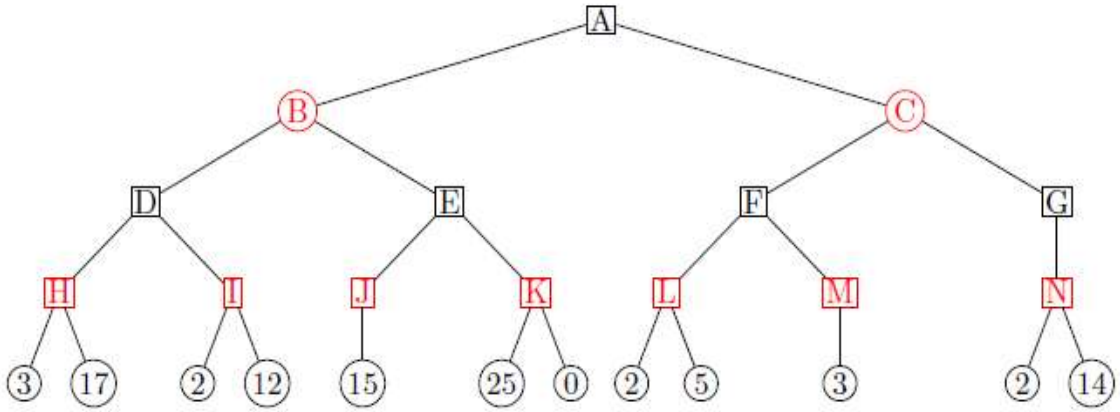
Level 1 (Max)

Level 2 (Min)

Level 3 (Max)

Level 4 (Min)

Level 5 (Leaves)



(i) [3 pts] Run minimax. What will be the value of the root (A)?

(ii) [5 pts] After running minimax, indicate the branches that will be pruned with alpha-beta pruning? You can indicate an edge by the two sides (e.g., B-E or L-5). If pruning occurs at a lower depth, just indicate the main edge, and explain if all successor edges will also be pruned.

(iii) [4 pts] Assume we are very kind and we want to give two chances to the Opponent (Min in red), so we run min() also at the third level and max() in the fourth level (D, E, F, G become Red running Min() instead of Max() and H-N will run Max()) (The layers will be thus Max(), Min(), Min() then Max()). We run Minimax with alpha-beta pruning. Which edges or leaf nodes will be pruned?

(iv) [3 pts] Now assume all the games with the same structure (back to original tree) and any possible values on the leaves. In the best and worst case, how many leaves will be pruned by alpha-beta pruning?

Question 4 Where to find your friend Saturday afternoon (Naïve Bayes)

Reference: https://ai.stanford.edu/~latombe/cs121/2011/hw/hw7.pdf (with some modifications)

You have a friend who only does **one of these three (3) things** every Saturday afternoon: going to the cinema, playing tennis, or just staying in. You have observed your friend's behavior over 12 different weekends. On each of these weekends, you have recorded the weather (sunny, windy, or rainy), whether she had drawn cash from an ATM machine (rich or poor), and whether she had an exam during the coming week (exam or no-exam). You have built the following data table:

Observation	Weather	Cash	Exam	Decision
1	Sunny	Rich	Yes	Cinema
2	Sunny	Rich	No	Tennis
3	Windy	Rich	No	Cinema
4	Rainy	Poor	Yes	Cinema
5	Rainy	Rich	No	Stay-in
6	Rainy	Poor	No	Cinema
7	Windy	Poor	Yes	Cinema
8	Windy	Rich	Yes	Stay-in
9	Windy	Rich	No	Cinema
10	Sunny	Rich	No	Tennis
11	Sunny	Poor	Yes	Tennis
12	Rainy	Rich	No	Stay-in

Assume she is a new friend, so you do not have any prior knowledge about her interest in doing any of these activities. **You know that this weekend it is Sunny, she did not draw money (poor), and she has no exam.**

a) [12 pts] Where is the most probable place (activity) to find your friend this Saturday afternoon, i.e., Cinema, Tennis court or home (stay in)? (You can assume no smoothing). [Hint: It is a Naïve Bayes, so you calculate all required probabilities].

b) [2 pts] Now, let's check your calculated answer. Complete the Python code of the assignment (attached) and run it. The sections with '`'XXXXX ADD YOUR CODE HERE XXXXXXX'`' should be completed before running the notebook. Take a snapshot of your output and attach it to your answer sheet.

c) [1 pts] How the answer will change if you know that your friend is very outgoing, so the prior probabilities that she does any of these four activities are ['Cinema': 0.4 , 'Tennis': 0.4, 'Stay-in': 0.2] (only in the Python code, no need to do manual calculation).

Question 5 Finding my friend with Decision Tree (Using the same dataset as Question 4)

You are not sure of the Naïve Bayes Classifier prediction; therefore, you decide to also build a decision tree. Use the method described in the class.

1) [8 pts] Make a simple decision tree (depth=1) from a single attribute (Weather, Cash, or Exam).

a. Which attribute will you select?

b. Based on the attribute that you selected, what would be the decision (prediction)? What would be the performance metrics of this 1-d tree (accuracy, recall, precision, F1 score) ?

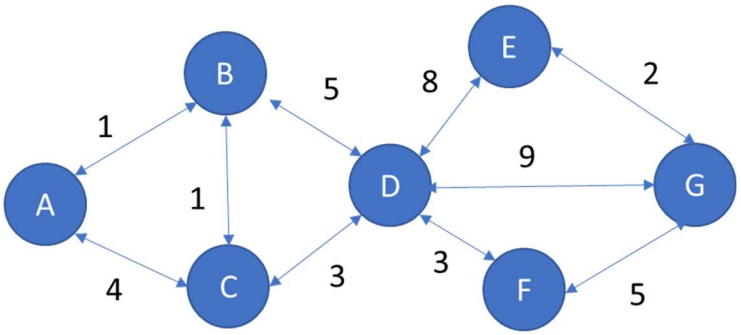
2) [5 pts] We can see that variable Weather has three levels (possible values: sunny, windy, and rainy). Assume you are told to use Weather to do the first cut (branching). Compare these two situations:

- A branching factor of 3 is allowed (for Weather='Sunny', 'Rainy', and 'Windy')
- Only a branching factor of 2 is allowed.

(**Hint**: You can reuse your calculations from the first part).

3) [2 pts] Now, let's check your answer. Run the Python code of the assignment (attached). Take a snapshot of your output and attach it to your answer sheet.

Question 6 [6 pts BONUS] Informed Search



Consider the search graph above where G is the goal state, and A is the start. Numbers on the edges represent the cost of the move. Also consider the suggested heuristic h1(n).

a) [2pts] Is h1(n) consistent?
b) [2 pts] Run Algorithm A with this heuristic. Show the intermediate steps and the found path.

Node	A	B	C	D	E	F	G
h1 (.)	10	12	10	8	1	4.5	0

Now consider the following new heuristic h2(n):

Node	A	B	C	D	E	F	G
h2 (.)	10	?	9	7	1.5	4.5	0

c) [1pts] Which range of values of h2(B) results in h2() being admissible?
d) [1 pts] which range of values of h2(B) results in h2() being consistent?

Question 7) [6 pts BONUS] Our version of Tic-Tac-Tao

Assume this version of Tic-Tac-Tao. A player can decide (has the option) to play one or two rounds consecutively. However, if he/she plays two rounds, the opponent can also select to play one or two rounds. So, if Max plays two consecutive rounds, Min can play one or two rounds if she wants.

[Hint: Action space is now determined by two parameters: deciding to draw one or two symbols and on which cells].

a) How do you represent the state?
b) Draw only the first round of the game (starting from an empty board, Max (X) moves.
c) What is the branching factor?

(Board is symmetric, so only the non-symmetric states for sections b and c are enough. For example, with a single move, we had only these 3 non-symmetric states).

X		

	X	

	X	