The National Higher School of Artificial Intelligence
Introduction to Artificial Intelligence
Final Exam 10/06/2023
Duration: 2 hours

Last Name	
First Name	
Group #	

Exercise 1		**/ 6**
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TOTAL		**/ 20**

1. **ANSWER ON THESE EXERCISE STATEMENT PAGES. IF YOU DO NOT HAVE ENOUGH, SPACE WRITE ON THE BACK OF THE SAME PAGE.**
2. **Use a PEN NOT a PENCIL everywhere.**
3. **DO NOT** USE ANY RED OR PINK (OR RELATED) COLOUR IN YOUR ANSWERS**!**
4. **WRITE NEATLY SO AS NOT TO BE PENALISED!**

Exercise 1: 6 marks

A. For each of the following statements in the table, write on the second column which one is TRUE and which one is FALSE and give a brief explanation. If it is by definition, say so.

N°	Statement	TRUE / FALSE
1	*Best-first search when the queue is sorted by f(n) = g(n) + h (n) is both complete and optimal when the heuristic is admissible and the total cost estimate f(n) is monotonic increasing on any path to a goal node.*	
2	*Greedy best-first search (sort queue by h(n)) is both complete and optimal when the heuristic is admissible and the path cost never decreases.*	
3	*Beam search uses O(bd) space and O(bd) time.*	
4	*An admissible heuristic NEVER OVER-ESTIMATES the remaining cost (or distance) to the goal.*	
5	*Uniform-cost search (sort queue by g(n)) is both complete and optimal when the path cost never decreases.*	
6	*Simulated annealing uses O(constant) space and can escape from local optima.*	

7	*Genetic algorithms use O(1) constant space and can escape from local optima.*	

Answer the following questions and give a brief explanation each time.

B. *Which of the search techniques you know is equivalent to Local beam search with k=1.*

C. Suppose you want to execute a Genetic algorithm with population size N=1. Explain what would happen, i.e. explain the behaviour of the algorithm.

D. What are search trees for Constraint Satisfaction Problems? Describe what do nodes and branches in a search tree represent for CSP. (5 marks)

Exercise 2: 2 marks

In order to perform a move in the game a player has to roll a die. If the outcome is odd (1,3 or 5) the player has three possible moves that will reach states with utilities: 4, 5 and 10. If the outcome of the die is 2 or 4, the player has two possible moves that will reach states with utilities: 4, and 8. Finally, if the outcome of the die is 6, there are three moves that reach states with utilities 5, 7 and 9. Draw the expectiminimax tree and calculate the expectiminimax value of the root node (after calculating the chance nodes values) given that:

a) The player is a maximum player.

b) The player is a minimum player.

Exercise 3: **6 marks**

A. Rewrite the following statements in First-Order Logic. You may use appropriate predicates.

i. Every coyote chases some roadrunner.

ii. Every roadrunner who says ``beep-beep" is smart.

iii. No coyote catches any smart roadrunner.

iv. Any coyote who chases some roadrunner but does not catch it is frustrated.

B. Convert the statements to Conjunctive Normal Form showing all the steps.

i.

ii.

iii.

iv.

Exercise 4: **6 marks**

A. Rewrite the following statements in First-Order Logic. Choose appropriate predicates and constants.

1. All dogs howl at night.

2. Anyone who has any cats will not have any mice.

3. Light sleepers do not have anything which howls at night.

4. Tariq has either a cat or a dog.

5. (Conclusion) If Tariq is a light sleeper, then Tariq does not have any mice.

B. Convert the statements to Conjunctive Normal Form showing all the steps.

1.

2.

3.

4.

5.

Give (recap) here the resulting Knowledge Base (in CNF) :

C. On the back of this page, apply the Resolution inference rule to prove the conclusion (statement 5) from the first four statements (statements 1 to 4). Make sure that, at each step, all the substitutions are shown as well as the parent clauses and the resolvent.