

**Introduction to AI, Test**  
27-OCT-2023, Class Q3/1011, 14:00-16:00

**No notes, no communication.**

The number between brackets [] indicates **the points of the exercise**.

Write the answer of each exercise on a **different piece of paper**.

Always **justify your answer (JYA)**; otherwise, it will not be taken into account.

Do not forget to put your **name and coordinates** (row and column).

1. [1] Ten historical facts about Artificial Intelligence are given next:

- A. Perceptron of Roseblatt
- F. Turing Test
- B. AlphaGo
- G. AI winter (Lighthill memo)
- C. Expert systems and multilevel neural networks

- H. First chess computer program ever written
- D. Deep Blue
- I. Deep learning (Alexnet)
- E. Workshop in Darmouth College
- J. Watson wins Jeopardy!

Choose five of them (any five) and order them chronologically, between 1943 (computational neuron model of McCulloch and Pitts) and 2022 (ChatGPT is made publicly available). The precise years are not required, it is enough with the letters of these facts in relative order (from older to more recent)

2 [3] Consider the puzzle of 7: a 3x3 board with seven tiles numbered from 1 to 7 and two holes. **The only legal action is moving two pieces simultaneously to the two holes next to them in the previous state.**

a. [2] Develop a search tree to compute the moves that connect state A with the goal, as indicated below.

b. [1] The heuristic of #misplaced tiles, is also a lower bound for the number of actions required to reach the goal? What about the sum of Manhattan distances of misplaced tiles? Any additional suggestions for a lower bound of the number of actions to reach the goal in this version?



3. [3] For the task of recognizing typed languages, consider a language formed only by vowels and the symbol # that indicates start/end of a word (that is, your character set is {#,a,e,i,o,u}). Your corpus is formed by the following three words (lowercase characters):

#aei#  
#aoei#  
#aeoi#

from which you compute the conditioned probabilities. In a bigram model (pairs of consecutive characters):

- a. [1] How is it reflected that all words in the corpus start with "a" and end with "i"?
- b. [1] Compute the following conditioned probabilities:  $pr(oja)$ ,  $pr(ela)$ ,  $pr(elo)$ ,  $pr(ole)$ . (626)
- c. [1] How is reflected in the matrix of conditioned probabilities the fact that "u" does not appear in the corpus?

4. [3] Observe the robot on the left figure. It can only move on a plain, and it is enclosed in a square box, with floor, walls and ceiling. It is formed by a telescopic arm of length  $d$  that can vary from 0 to  $d_{max}$ , with a gripper at the top (not shown). The robot arm is anchored in the center of the floor by a joint that can rotate from  $0^\circ$  to  $180^\circ$ . Using as internal coordinates the angle between the arm and the floor and the robot length  $d$ , it is requested:

a. [1] Are all points in the working space reachable? Draw the configuration space. Are all points in this space reachable? Why?

b.[1] Provide a **qualitative description** of the configuration space.

c [1] Observe the robot of the right figure. It is as the previous one, plus a horizontal obstacle in the left wall. **Modify the configuration space** of (b) to prevent collisions with this obstacle.

