

## CI Final Exam

Date: 10/1/2023

Duration: 11:30h to 13:00h

*Answer the exam in three different page sets: questions from 1 to 3, 4 to 6 and 7 to 8. Do not forget to write your name in ALL the sheets.*

1. Suppose we are working with a Multi-Layer Perceptron with the following properties:

- It has 2 input units, one hidden layer with 3 hidden units, and 1 output unit
- The activation function of the hidden units is

$$f(x) = \begin{cases} 0 & \text{if } x \leq -1 \\ \frac{1}{2}(x+1) & \text{if } -1 < x < 1 \\ 1 & \text{if } x \geq 1 \end{cases}$$

- The activation function of the output units is

$$f(x) = x$$

- The weight matrix connecting the input and the hidden layer is

$$W1 = \begin{pmatrix} 0.10 & -0.40 \\ -0.25 & 0.60 \\ 0.30 & -0.75 \end{pmatrix}$$

- The weight matrix connecting the hidden and the output layers is

$$W2 = \begin{pmatrix} 0.1 & -0.2 & 0.3 \end{pmatrix}$$

Suppose that the input vector is  $(1.5, -1.5)$ .

- 1.1. What is the pre-activation (net-input) of every unit in the network?
- 1.2. What is the activation (net-output) of every unit in the network?
2. What is the main difference between the convolution operation in Convolutional Neural Networks and the standard inner product in Multi-layer Perceptrons? In which situations is more suitable using one or another?
3. In the Neural Networks explained in the course, what is the standard way to detect the presence of overfitting?
4. What are the main differences between an Evolution Strategy and a (standard or canonical) Genetic Algorithm? Express them using a table.
5. Propose a (not necessarily new) crossover operator for the **travelling salesman problem** and justify its appropriateness as compared to standard crossover operators.

6. Examine the sentence:

*“Some people say 75% of dogs will reach mature age”*

Specify the sources of uncertainty in the sentence and what techniques could cope with them.

7. What is the major problem that appears when designing fuzzy rule based systems (FRBS) by means of evolutionary algorithms? Explain it. Describe also, briefly, how the three main classical GFS learning approaches deal with this problem.
8. Are the following statements true or false? Reason briefly the answers.
- 8.1. The membership functions represent distributions of possibility rather than distributions of probability.
  - 8.2. Both Mamdani and TSK fuzzy rule base systems guarantee the continuity of the output surface.
  - 8.3. TSK approximates a non-linear system with a combination of several linear systems.
  - 8.4. ANFIS deals with parameter identification but not with structure identification.