

AY: 2022-2023
RESIT | AI-ECUE122
July 2023

M1-S1: Dept. of Electrical Engineering
Teacher: A. Mhamdi
Time Limit: 1½ h

This document contains 5 pages numbered from 1/5 to 5/5. As soon as it is handed over to you, make sure that it is complete. The 4 tasks are independent and can be treated in the order that suits you.

The following rules apply:

- ❶ No document is allowed in the examination room.
- ❷ Any electronic material, except basic calculator, is prohibited.
- ❸ Mysterious or unsupported answers will not receive full credit.
- ❹ Round results to the nearest thousandth (i.e., third digit after the decimal point).
- ❺ Task N°4: Each correct answer will grant a mark with no negative scoring.

SELF-REVIEW

Task	1	2	3	4	Total
Points	7½	5	4	3½	20
Score					

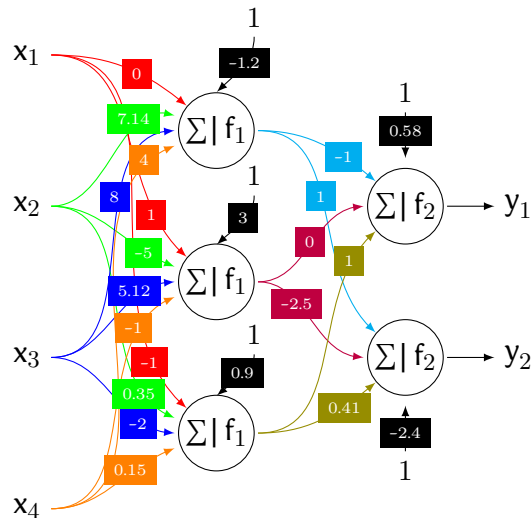
Task N°1

⌚ 30mn | (7½ points)

Given the following weight matrices and biases vectors. Draw the corresponding neural network architecture. (Place the values of the synaptic weights and biases on the arrows.)

$$\mathcal{W}^{(1)} = \begin{pmatrix} 0 & 7.14 & 8 & 4 \\ 1 & -5 & 5.12 & -1 \\ -1 & 0.35 & -2 & 0.15 \end{pmatrix} \quad \text{and} \quad \mathbf{b}^{(1)} = \begin{pmatrix} -1.2 \\ 3 \\ 0.9 \end{pmatrix}$$

$$\mathcal{W}^{(2)} = \begin{pmatrix} -1 & 0 & 1 \\ 1 & -2.5 & 0.41 \end{pmatrix} \quad \text{and} \quad \mathbf{b}^{(2)} = \begin{pmatrix} 0.58 \\ -2.4 \end{pmatrix}$$



Task N°2

⌚ 20mn | (5 points)

We consider the vastly simplified model of real neuron, also known as **Threshold Logic Unit**. The processing element sums the weighted inputs $w_1x_1 + w_2x_2$, add a bias b and then applies a non linear activation function. The output transmits +1 *if and only if* the input is positive. Otherwise, it transmits -1.

Consider the problem approximating an \vee (**OR**) gate. Use bipolar data instead of binary data for the inputs x_1 and x_2 , i.e. ± 1 . Weights and bias are all set initially to zero: $w_1 = w_2 = b = 0$.

On your answer sheet, reproduce and fill in, according to **Rosenblatt learning rule**, the following table. y and \hat{y} denote the target (i.e. *the actual output of the gate*) and the output of the perceptron. The factor α is set to 1.

x_1	x_2	b	\hat{y}	y	Δw_1	Δw_2	Δb	w_1	w_2	b
-1	-1	1	1	-1	1	1	-1	1	1	-1
-1	1	1	-1	1	-1	1	1	0	2	0
1	-1	1	-1	1	1	-1	1	1	1	1
1	1	1	1	1	0	0	0	1	1	1

Task N°3

⌚ 20mn | (4 points)

The code given by FIG. 1, p. 3 allows approximating a non-linear function, using a neural network. Provide the result of the approximation and highlight all intermediate steps.

```

julia> f
Chain(
  Dense{2 => 2, relu},          # 6 parameters
  Dense{2 => 1, σ},            # 3 parameters
)                               # Total: 4 arrays, 9 parameters, 292 bytes.

julia> f.layers[1].weight
2×2 Matrix{Float32}:
 1.05509   0.0551044
 0.467942 -0.951435

julia> f.layers[1].bias
2-element Vector{Float32}:
 0.0
 0.0

julia> f.layers[2].weight
1×2 Matrix{Float32}:
 1.15204 -0.476447

julia> f.layers[2].bias
1-element Vector{Float32}:
 0.0

julia> f([-1.3; 4.5]) # f([-1.3; 4.5])

```

FIG. 1. Julia REPL

Result is 1-element vectorFloat64: 0.5

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ID:

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✂

ANSWER SHEET

Task N°4

⌚ 20mn | (3½ points)

- (a) (½ point) What is the main motivation for using activation functions in ANN?
- ☐ Transforming continuous values into 'ON' (1) or 'OFF' (0) values.
 - ☐ Help avoiding the vanishing/exploding gradient problem.
 - ☒ Capturing complex non-linear patterns.
 - ☐ Their ability to activate each neurons individually.
- (b) (½ point) You work for an insurance company. Which machine learning project would add the most value for the company!
- ☐ Create an artificial neural network that would host the company directory.
 - ☒ Use machine learning to better predict risk.
 - ☐ Create an algorithm that consolidates all of your Excel spreadsheets into one data lake.
 - ☐ Use machine learning and big data to research salary requirements.
- (c) (½ point) What is one reason not to use the same data for both your training set and your testing set?
- ☐ You will almost certainly underfit the model.
 - ☐ You will pick the wrong algorithm.
 - ☐ You might not have enough data for both.
 - ☒ You will almost certainly overfit the model.
- (d) (½ point) What is the form of fuzzy logic?
- ☐ Two-valued logic
 - ☒ Many-valued logic
 - ☐ Crisp set logic
- (e) (½ point) The values of the set membership is represented by “_____”.
- ☐ discrete set
 - ☒ degrees of truth
 - ☐ probabilities

DO NOT WRITE ANYTHING HERE

✂

(f) ($\frac{1}{2}$ point) « The room temperature is hot. » The linguistic variable hot can be represented by “_____”.

✓ fuzzy set

☐ crisp set

☐ fuzzy and crisp set

☐ none of the mentioned

(g) ($\frac{1}{2}$ point) Fuzzy set theory defines fuzzy operators. Choose the fuzzy operators from the following. ✓ ! ✓ ∨ ✓ ∧

ANSWERS