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

M1-S1: Dept. of Electrical Engineering
Teacher: A. Mhamdi
Time Limit: $1\frac{1}{2}$ **h**

This document contains **5** pages numbered from **1** to **5**. Upon receiving it, verify completeness. The **4** tasks are independent and can be solved in any order you prefer. The following rules apply:

❶ **A handwritten double-sided A4** sheet is permitted.

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	$7\frac{1}{2}$	5	4	$3\frac{1}{2}$	20
Score					

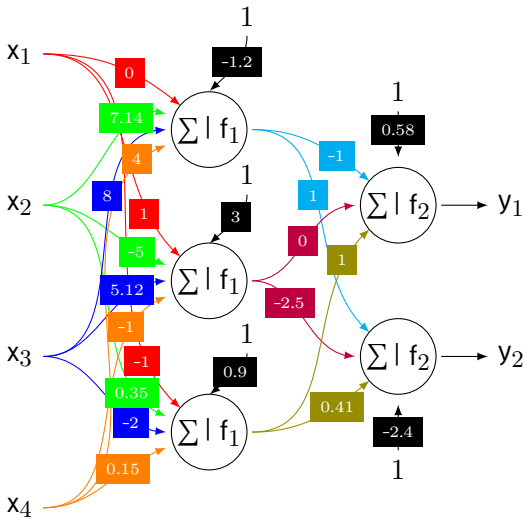
Task N°1

⏳ 30mn | ($7\frac{1}{2}$ 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.)*

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

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



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 learning rate η is set to 0.5.

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.

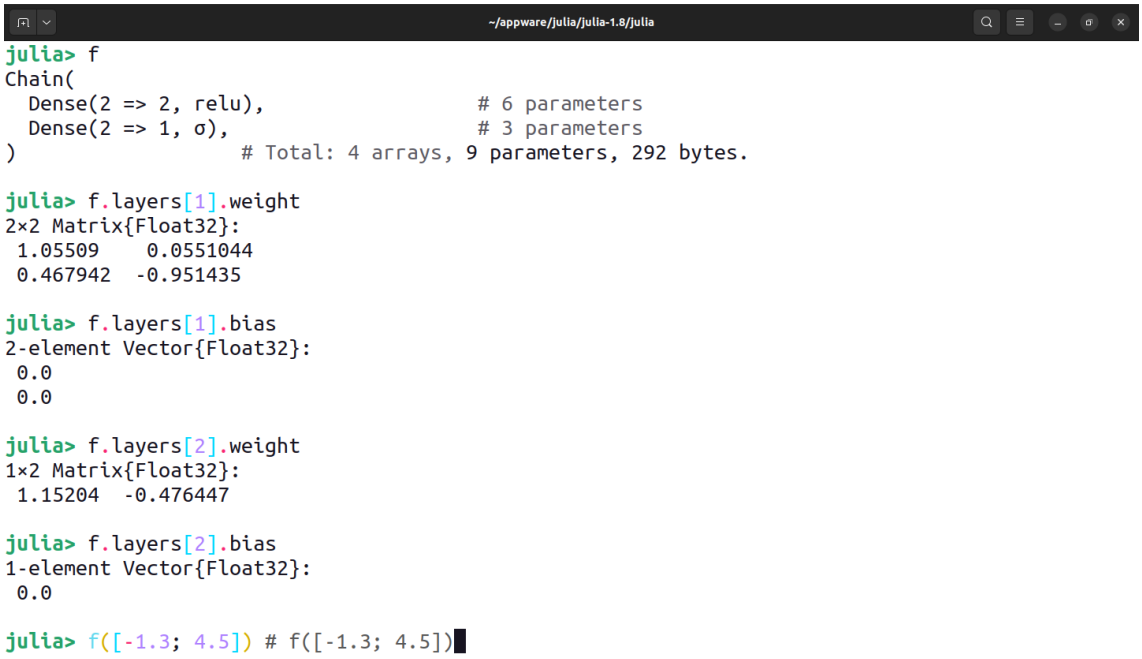


FIG. 1. Julia REPL

Result is 1-element vectorFloat64: 0.5

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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

(f) (½ point) « The room temperature is hot. » The linguistic variable hot can be represented by "_____".

DO NOT WRITE ANYTHING HERE

✂- -

√ fuzzy set

◯ crisp set

◯ fuzzy and crisp set

◯ none of the mentioned

(g) (½ point) Fuzzy set theory defines fuzzy operators. Choose the fuzzy operators from the following. √ ! √ $\vee$ √ $\wedge$