



Iran University of Science & Technology

School of Computer Engineering

Assignment #4

Neural Networks

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Due: 1403/09/23

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Notes:

1. Submit the answers in a complete PDF file and the code for the questions in the .ipynb format (including the notebook cell outputs) in a compressed file named HW4_StudentID.zip by the specified deadline.
2. A total of 72 + 48 hours of delay in submitting the answers is allowed across all projects. After that, for each additional day of delay, 10% of the score will be deducted.
3. If a student submits the project earlier than the deadline and achieves 75% of the score, up to 24 hours will be added to their allowable delay time.
4. The maximum delay for submitting each assignment is 5 days, and after 5 days, submission will not be accepted.
5. It is important to note that the explanation of the code and the obtained results must be included in the PDF file. Code without a report will result in a score deduction.
6. The evaluation of the assignment will be based on the correctness of the solution and the completeness and accuracy of the report.
7. Assignments must be completed individually, and group work on assignments is not allowed.
8. Please allocate sufficient time for the assignment and avoid leaving it until the last days.
9. You can ask your questions in the relevant group.

good luck.

Problem 1

Answer the following questions: **(15 points)**

- In your opinion, why does the Art network perform poorly when there is a lot of noise? (A logical analysis, even if possibly incorrect, is sufficient.)
- Describe the "Grandmother Node" problem in Art networks.
- We know that in RCE, there are no errors in the training dataset, but there is a possibility of errors in the testing dataset. In your opinion, what is the reason for the lack of errors during training and the potential for errors during testing?

Problem 2

The variables "weight" with the term "fat" and "age" with the term "young" are defined as follows: **(35 points)**

$$\mu_{fat}(u) = \begin{cases} 0 & u \in (-\infty, 50] \\ 1 - \left(\frac{u - 150}{100}\right)^2 & u \in (50, 150] \\ 1 & u \in (150, +\infty) \end{cases}$$

$$\mu_{young}(u) = \begin{cases} 1 & u \in (-\infty, 25] \\ \left(1 + \left(\frac{u - 25}{5}\right)^2\right)^{-1} & u \in (25, 100] \\ 0 & u \in (100, +\infty) \end{cases}$$

- Are the above membership functions representative of the stated terms? Explain briefly.
- Define membership functions for the terms "old," "slim," and "average weight" according to your preference and explain why they are appropriate.
- Consider two people with weights 70 and 110 in kg, and ages 60 and 30 in years, respectively. Using fuzzy reasoning, what can be said about the truth

of the following statement? (The final output is a definite number, not a fuzzy term):

"If the second person is a very fat young person, then they are not relatively slimmer than the first person."

Problem 3

At first just name all the steps for designing a fuzzy system, then design a fuzzy system that uniformly approximates the function $g(x_1, x_2)$ with $\varepsilon = 0.1$ **(25 points)**

$$g(x_1, x_2) = \frac{1}{3 + x_1 + x_2} \quad U : [-1, 1] \times [-1, 1]$$

Problem 4

In an air handling system, the blower motor speed (V) should be adjusted based on the received temperature (T) and the measured humidity (H). The temperature ranges from -40 to +40 degrees, and the humidity is measured between 10% and 100%. The motor speed also ranges from zero to 20. According to expert opinions, the motor speed should follow the following empirical rules:

1. If the temperature is high and the humidity is low, the motor speed should be low.
2. If the temperature is moderate and the humidity is low, the motor speed should be low.
3. If the temperature is low and the humidity is low, the motor speed should be high.
4. If the humidity is moderate, the motor speed should be high.
5. If the temperature is low and the humidity is high, the motor speed should be high.

Design a fuzzy system (determine all parameters precisely) to control this air handling unit and specify the motor speed when the air temperature is 20 degrees and the humidity is 90%.

Finally, test three more inputs and report the fuzzy system's output. Check if these outputs are logical considering the problem and the rules. **(25 points)**