



Artificial Intelligence and Expert Systems

Assignment 3

Instructors:

Dr. Esmail Najafi

Armin Ghanbarzadeh

Reza Behbahani Nezhad

Due Date: 4 Khordad, 1403

Problem 1

Given A and B as fuzzy subsets of non-negative real number reference sets and A' and B' are complementary to A and B :

$$A(x) = \begin{cases} 0 & \text{if } 0 < x < 1 \\ x - 1 & \text{if } 1 \leq x < 2 \\ 1 & \text{if } 2 \leq x < 3 \\ 4 - x & \text{if } 3 \leq x < 4 \\ 0 & \text{if } 4 \leq x \end{cases}$$
$$B(x) = \begin{cases} e^{x-3} & \text{if } 0 < x < 3 \\ 1 & \text{if } 3 \leq x < 5 \\ 1 - \frac{x-5}{5} & \text{if } 5 \leq x < 10 \\ 0 & \text{if } 10 \leq x \end{cases}$$

Plot the following sets:

- (a) A set
- (b) B set
- (c) A' set
- (d) B' set
- (e) $A \cup B$
- (f) $A \cap B$
- (g) $A' \cup B'$
- (h) $A \cap B'$

Is A a convex set? What about B ?

Problem 2

Imagine that you work in a company and you are asked to design a system which can **predict the probable salary of an employee based on their years of experience**. For more information, you are given a dataset which contains information about years of experience and salary of 30 employees. Without using the Simulink package for fuzzy logic systems and by using pure MATLAB script which satisfies the following conditions:

- The function takes the years of experience as the input and outputs the estimated salary.
- Has 5 membership functions for the input.
- Has 5 membership functions for the output.
- Has 5 membership functions for the output.
- Rules are written inside the function.

Problem 3

Imagine there is a house which only has two rooms and, in each room, there is an air conditioner. A fuzzy controller should be designed to control temperature in these rooms. This controller takes the difference between desired and measured temperatures in both rooms and outputs the required heat of each air conditioner. The governing equations are:

$$\begin{aligned}\frac{dT_1}{dt} &= -0.05 T_1 + 0.01T_2 + 0.008 T_{out} + u_{ac1} \\ \frac{dT_2}{dt} &= -0.039 T_2 + 0.01T_1 + 0.0075 T_{out} + u_{ac2}\end{aligned}$$

where T_1 is the temperature in room 1, T_2 the temperature in room 2, T_{out} the outside temperature, u_{ac1} , the required heat for the air conditioner in room 1 and u_{ac2} , the required heat for the air conditioner in room 2. (The air conditioner can produce both warm and cold air)

Design a fuzzy controller and simulate the result for $T_{out} = -15^\circ\text{C}$ with various initial conditions.

Important Notes

- Please submit your homework assignment as a zip file containing **(a)** a PDF report (analysis, results, methodology, ...), and **(b)** code files necessary to reproduce your results.
- All grading will be based on the content of the PDF report. Make sure to include and explain your code in the report.
- Please make sure to submit your solutions by the due date. No late submissions will be accepted.
- Assignments are to be completed individually. Any similarities between assignments will be subject to reduced grades.
- If you have any questions, feel free to ask.

Good Luck!