

1. INTRODUCTION

Banco Pichin wants to create a decision-support system for granting personal loans. After examining several alternatives, they settled on a Mamdani fuzzy inference system (MFIS). The bank has hired your company, C3L, to create this system.

This project consists of the creation of the MFIS and the elaboration of the deliverables that are described later. Your team has already executed the first two phases of the project: Definition of variables and Definition of rules.

2. PHASE 1: DEFINITION OF VARIABLES

The decision whether or not to grant the loan is based on the following information about the applicant and the application:

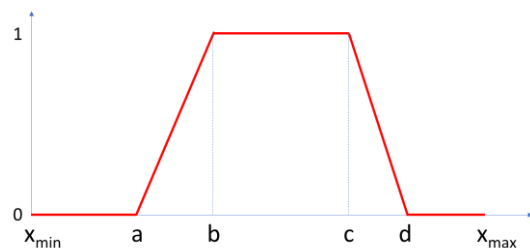
- Income level.
- Assets in possession: real estate, vehicles, etc.
- Employment stability: seniority, type of contract, etc.
- Loan amount in relation to monthly income.
- Loan and payment history.
- Age.

Each of these variables is typified by one or more fuzzy sets whose membership functions have trapezoidal or triangular shapes, that is, they are composed of straight segments. The file *InputVarSets.txt* contains the description of these sets, one set in each line. The format is:

$var = label, x_{min}, x_{max}, a, b, c, d$

Where

- *var* corresponds to one of the input variables ("age", "income", ...)
- *label* is the name of the fuzzy set in question ("young", "adult", ...)
- x_{min}, x_{max} determine the range of values of *var*
- a, b, c, d are the significant points of the trapezoid, as shown in this example:



The result of the inference system will be the risk level of the request. More information can be found at *Risks.txt*.

3. PHASE 2: DEFINITION OF THE INFERENCE RULES

Several bank experts have provided the rules found in *Rules.txt* . The format of each rule is

$name, var_0=label_0, var_1=label_1, \dots var_n=label_n$

Where:

- *name* is the name of the rule
- $var_0=label_0$ is the consequent of the rule
- $var_1=label_1$ AND ... AND $var_n=label_n$ is the antecedent of the rule

The antecedent of the rules only supports the logical AND operator. In the file it appears as a list of *var = label pairs* , but the AND is implicit.

4. OPERATION OF THE INFERENCE SYSTEM

Once the system is built, tested and accepted, each day you will be presented with a file with loan application data (*Applications.txt*). The system will generate a file with the risk values of each of the requests (*Results.txt*).

5. LIST OF DELIVERABLES

The project consists of the preparation of the following deliverables:

- D01 Project report.
- D02 Video.
- D03 Source code.
- D04 Results.
- D05 Analysis.

D01 Project Report

It is the document that C3L must present to Banco Pichin as a description of the project carried out. At a minimum, it must contain the following sections (the ranges of word numbers in parentheses are merely indicative):

- Executive summary: summary explanation of the project. It must include a diagram that shows, at a high level, the system with its inputs and outputs. (150-200 words).
- Description of the inference system: explanation of the constructed inference system (200-400 words). The use of images will be positively valued.
- Methodology: list of project execution phases. For each phase, the tasks performed will be described (400-800 words). The use of images (for example, one of the fuzzy sets used) will be positively valued. You should avoid going into details of the code.
- Budget: price that the CL3 company will charge Banco Pichin for this project, with a brief justification for it .

D02 Video

A video in which team members explain the Project Report to Banco Pichin and. Duration: between 3 and 5 minutes.

D03 Source code

The Python program that codes the built inference system. Section 7 of this document provides some recommendations and aids for developing the source code.

D04 Results

File produced by the inference system in response to the requests that appear in the *Applications.txt* file.

D05 Analysis

One year after the project was delivered, a series of questions arise related to it or to the Mamdani inference system in general. In this deliverable you must answer these questions to the best of your ability. The questions are:

- Q1. Experts observe that the results are not always the desired ones. This is because some rules are very important, which they consider “golden rules”, while others may serve in some cases, but are less relevant to the risk. How could Mamdani's inference system be modified to solve this problem?
- Q2. Another observation is that extreme risk values are never obtained. What could it be due to? What is the maximum value that can be obtained with the described system?
- Q3. Banco Pichin has been acquired by a much larger bank. Within a month, the system will have to process hundreds of requests more than now and the result is to be obtained in just a few seconds to impress the new owner. You can't spend anything on hardware and all possible optimizations to the software have already been made. How could it be achieved?

6. PROJECT DELIVERY RULES

- This project must be done in groups of 3 students.
- Each group must submit a zip file through the link provided in Aula Global.
- The name of the zip file must be “IA Project 2024 <st-code1><st-code2><st-code3>.zip”, where <st-codex> are the last six digits of the NIA of each of the members of the group.
 - Example: IA Project 2024 123456 345678 456789.zip
- The zip file will include five files with the deliverables described above:
 - D01 Project report.pdf
 - D02 Video.mp4 (or other standard video format)
 - D03 Source code.py
 - D04 Results.txt
 - D05 Analysis.pdf
- The deadline to submit the project is May 15 at 11:59pm.

7. PROGRAMMING AIDS

Recommendations:

- We suggest the use of *numpy* and *skfuzzy* libraries.
- **It is NOT allowed to use the *skfuzzy control* module** (*ControlSystem* , etc.).
- The attached file *MFIS_Classes.py* contains the definition of classes that may be useful in this project.
- The attached file *MFIS_Read_Functions.py* contains several functions to read the *.txt* files and store their content in objects of the classes defined in the previous file.