Assignment: a fuzzy expert system to estimate basketball player's performance

This exercise takes inspiration from sports analytics. Basketball is one of the sports that uses different kind of statistical and data analysis methods. We want to build a fuzzy expert system to determine the player winning percentage from a set of indicators. ***This assignment exercise can be done in pairs of students.***

To make this prediction, a system with a single block of rules must be constructed. Of course, this system will be just a simplification of a real one, which would require more inputs and probably a hierarchical structure. Looking at the paper indicated below, you must select 4 input variables. They must use different scales and different units (percentage, ratio, measurement, …). An additional variable (5^{th}) will be "Years of experience", and it will condition the way the other variables are used and related, because a player with 2 years of experience cannot be evaluated the same than one with 15 years of experience.

To define the rules, you can also take inspiration from the paper, from other related works, as well as, you can also add your own knowledge about the sport.

Resources

D'Urso, P., De Giovanni, L. & Vitale, V. A Bayesian network to analyse basketball players' performances: a multivariate copula-based approach. *Annals in Operations Research,* **325**, 419–440 (2023). https://link.springer.com/article/10.1007/s10479-022-04871-5

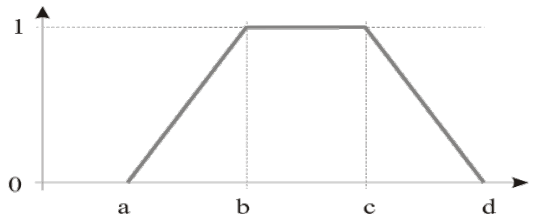
NBA players data: https://www.basketball-reference.com/players/j/jamesle01.html

The tasks to be done are:

TASK 1: Definition of the input and output linguistic variables.

For each variable you must decide the number of terms, the labels and the corresponding fuzzy sets (by defining their membership functions). Remember they must satisfy the property of Fuzzy Partition.

You must use the triangular and trapezoidal functions to define each of the linguistic terms of the variables, using the (a,b,c,d) format, being its graphical representation:



TASK 2: Define the rules for the expert system

You must define a set of conjunctive rules. Decide appropriate premises and assign a degree of support to each rule. The rules must cover all possible combinations of input values, but you should use rules of different lengths. Support your definition of rules with evidences you find in the papers. Avoid inconsistencies in the rules. The number of rules should not exceed 30-35, in order make possible its manual definition and analysis.

TASK 3: Implement the fuzzy expert system using Matlab Fuzzy Toolkit.

Consider a Mamdani system (min as t-norm and max as t-conorm) and a Center of Area as defuzzification method. Validate the system using the 3D plot of the rules.

TASK 4: Select four different basketball players from NBA and execute the system.

Explain the situation represented in each of the players. You must find appropriate test cases that represent different situations. Some of them must activate more than one label of the same variable. Report the results of each testing case with screenshots and explanations that justify the output obtained (i.e. showing the activations of rules). Compare the results obtained with different defuzzification methods.

TASK 5: Design (just graphically, no implementation) a more complete fuzzy expert system that includes more indicators about the players. Show in a figure the inputs, outputs, and rule blocks that you propose for such expert system. No specific definition of variables nor rules is required.

Submission and deadline:

- A detailed report of the work done in the 5 previous tasks. Report must include all the details about the expert system done in Tasks 1-3 (definitions of variables, rules, screeshots, etc.), about the testing in Task 4 and the answer of Task 5. Matlab files will not be checked during evaluation. Max number of pages should not exceed 20.
- Deliver the Matlab files of your systems too, as validation of the work done and for revision if needed.
- Deadline: **17/12/2023**
- **Only one student of the team uploads the files in the URV virtual campus.**

Evaluation guide:

- TASK 1: definition of variables (correctness, motivation and justification) => 25 points
- TASK 2: definition of rules (correctness, motivation and justification) => 20 points
- TASK 3: implementation in Matlab => 20 points
- TASK 4: test cases, results and discussion => 25 points
- TASK 5: advanced design for FES => 10 points