

COMP4660/8420 Fuzzy Logic

Part 1: Theory

1. Why is Fuzzy Logic considered bio-inspired?
2. What might a real world application of Fuzzy Logic be? How would this scenario benefit from the use of Fuzzy Logic as opposed to Boolean Logic?
3. Define the set of natural numbers near 4 using a fuzzy set.
4. Give several examples of fuzzy rules. Label the linguistic variables, values, antecedents, and the consequents.
5. Consider the following fuzzy sets:
 $A = \{0.2/a, 0.4/b, 1/c, 0.8/d, 0/e\}$
 $B = \{0/a, 0.9/b, 0.3/c, 0.4/d, 0.1/e\}$

Calculate:

- a) The height, Support, Core, Cardinality, Complement for both A and B.
 - b) The alpha-cut and strong alpha-cut for both sets of $\alpha = 0.4$
 - c) Calculate the Union and Intersection of A and B
6. What is a fuzzy inference (rule based) system?
 7. What are the four steps performed in fuzzy inference systems? Briefly describe each step.
 8. What is the difference between Mamdani and Sugeno inference systems?
 9. What is the difference between Fuzzy C-Means clustering and k-means clustering?
 10. Discuss the differences between sparse hierarchical fuzzy systems and fuzzy signatures. How do they each achieve the goal of reducing the number of rules needed?

Part 2: Introduction to the Scikit Fuzzy

Now it's time to apply the concepts to some examples using a Python package called scikit-fuzzy. Working through these practical examples will help to develop your understanding.

Your first task is to build a Mamdani style inference system. You may find this link (https://pythonhosted.org/scikit-fuzzy/auto_examples/plot_tipping_problem.html) to be helpful for you understanding scikit-fuzzy. To get started, please run

```
pip install scikit-fuzzy
```

to install scikit-fuzzy on your machine.

Task 1: Fuzzy Inference System for a Temperature Control

1. What are the linguistic variables and the universe of discourse of each variable?
2. What are the fuzzy sets?
3. What are the fuzzy rules?
4. What is the defuzzification method?

Refer back to the lecture notes on Fuzzy Rule Based Systems to read through the Air Conditioner example. Change the fuzzy sets for the Temperature variable to be the same as in the lecture notes. Then change the fuzzy sets for the Power variable to be the same as the Speed Fuzzy sets in the lectures. Now modify the fuzzy rules to be the same as in the lecture notes. Now evaluate the FIS with the same inputs used in step 4.

5. What results do you get now? Do you think the modified FIS more accurately portrays the problem space? Why?
6. Do you agree with the range of the universe of discourse and the linguistic variable used? Are there any factors that you think have been overlooked and would be useful in altering the speed of the air conditioner?

Play around with FIS settings and comment on how it changes the FIS mode. You may like to experiment with different membership functions, more variables, different defuzzification methods etc.