Weeks 2 and 3: Practical Sections Activity

Masters in Computer Science, Faculty of Mathematics and Computer Science,
University of Lodz, Poland

1 Practical Exercise: Implementing a Basic Fuzzy Logic System

In this exercise, you will implement a simple fuzzy logic system using Python to understand the practical aspects of Fuzzy Logic discussed in the lecture. We will use the `skfuzzy` library, which provides good support for working with fuzzy logic.

1.1 Objective

To create a fuzzy logic system for a temperature control system that decides the speed of a fan based on the room temperature.

1.2 Requirements

- Python 3.x
- `skfuzzy` library (Install using `pip install -U scikit-fuzzy`)

1.3 Procedure

```python
# 1. Import the necessary libraries:
import numpy as np
import skfuzzy as fuzz
import matplotlib.pyplot as plt

# 2. Define the temperature range and the fan speed range:
temp = np.arange(0, 101, 1)
fan_speed = np.arange(0, 101, 1)

# 3. Define fuzzy membership functions for temperature and fan speed:
temp_low = fuzz.trimf(temp, [0, 0, 50])
temp_medium = fuzz.trimf(temp, [0, 50, 100])
temp_high = fuzz.trimf(temp, [50, 100, 100])
fan_slow = fuzz.trimf(fan_speed, [0, 0, 50])
fan_medium = fuzz.trimf(fan_speed, [0, 50, 100])
fan_fast = fuzz.trimf(fan_speed, [50, 100, 100])

# 4. Create fuzzy rules and the inference system:
# Rule 1: If temperature is low, then fan speed will be slow
rule1 = np.fmin(temp_low, fan_slow)
# Rule 2: If temperature is medium, then fan speed will be medium
rule2 = np.fmin(temp_medium, fan_medium)
# Rule 3: If temperature is high, then fan speed will be fast
rule3 = np.fmin(temp_high, fan_fast)
# Combine the rules
fan_speed_activation = np.fmax(rule1, np.fmax(rule2, rule3))

# 5. Defuzzify the output and visualize the result:
fan_speed_output = fuzz.defuzz(fan_speed, fan_speed_activation, 'centroid')
fan_speed_output_activation = fuzz.interp_membership(fan_speed, fan_speed_activation,
    fan_speed_output)
# Plot the results
plt.figure()
plt.plot(fan_speed, fan_slow, 'b', linewidth=1.5, label='Slow')
```

```
plt.plot(fan_speed, fan_medium, 'g', linewidth=1.5, label='Medium')
plt.plot(fan_speed, fan_fast, 'r', linewidth=1.5, label='Fast')
plt.fill_between(fan_speed, fan_speed_output_activation, alpha=0.7)
plt.plot([fan_speed_output, fan_speed_output], [0, fan_speed_output_activation], 'k')
plt.title('Fan speed control system')
plt.legend()
plt.show()
```

1.4 Expected Outcome

Upon completion of this practical exercise, you should have a working fuzzy logic-based temperature control system for fan speed. The plot will show the membership functions and the result of the fuzzy inference, providing a visual representation of how the fuzzy logic system operates.

1.5 Discussion

Reflect on how the fuzzy membership functions and rules impact the behavior of the control system. Experiment with different membership functions and rules to see how the system responds.

Practical Lecture Note by: Himanshi Liyanage (nishi.himanshi@wmii.uni.lodz.pl)