

Lab 4: Fuzzy Logic Cost-Benefit Analysis

```
In [1]: !pip install -U scikit-fuzzy matplotlib
```

```
Requirement already satisfied: scikit-fuzzy in /usr/local/lib/python3.12/dist-packages (0.5.0)
Requirement already satisfied: matplotlib in /usr/local/lib/python3.12/dist-packages (3.10.8)
Requirement already satisfied: contourpy>=1.0.1 in /usr/local/lib/python3.12/dist-packages (from matplotlib) (1.3.3)
Requirement already satisfied: cycler>=0.10 in /usr/local/lib/python3.12/dist-packages (from matplotlib) (0.12.1)
Requirement already satisfied: fonttools>=4.22.0 in /usr/local/lib/python3.12/dist-packages (from matplotlib) (4.61.1)
Requirement already satisfied: kiwisolver>=1.3.1 in /usr/local/lib/python3.12/dist-packages (from matplotlib) (1.4.9)
Requirement already satisfied: numpy>=1.23 in /usr/local/lib/python3.12/dist-packages (from matplotlib) (2.0.2)
Requirement already satisfied: packaging>=20.0 in /usr/local/lib/python3.12/dist-packages (from matplotlib) (25.0)
Requirement already satisfied: pillow>=8 in /usr/local/lib/python3.12/dist-packages (from matplotlib) (11.3.0)
Requirement already satisfied: pyparsing>=3 in /usr/local/lib/python3.12/dist-packages (from matplotlib) (3.2.5)
Requirement already satisfied: python-dateutil>=2.7 in /usr/local/lib/python3.12/dist-packages (from matplotlib) (2.9.0.post0)
Requirement already satisfied: six>=1.5 in /usr/local/lib/python3.12/dist-packages (from python-dateutil>=2.7->matplotlib) (1.17.0)
```

```
In [2]: import numpy as np
import skfuzzy
from skfuzzy import control
import matplotlib.pyplot as plt
```

Step 1. Define the domains for the inputs and output

```
In [6]: star_power_range = np.linspace(0, 10, 11)
hype_range = np.linspace(0, 10, 11)
anticipation_range = np.linspace(0, 10, 11)
```

Step 2. Create fuzzy variables (Antecedents and Consequent)

```
In [7]: star_power = control.Antecedent(star_power_range, 'star_power')
hype = control.Antecedent(hype_range, 'hype')
anticipation = control.Consequent(anticipation_range, 'anticipation')
```

Step 3. Set membership functions for each variable

```
In [8]: star_power['rookie'] = skfuzzy.trimf(star_power_range, [0, 0, 5])
star_power['superstar'] = skfuzzy.trimf(star_power_range, [5, 10, 10])

hype['low'] = skfuzzy.trimf(hype_range, [0, 0, 5])
hype['major'] = skfuzzy.trimf(hype_range, [5, 10, 10])

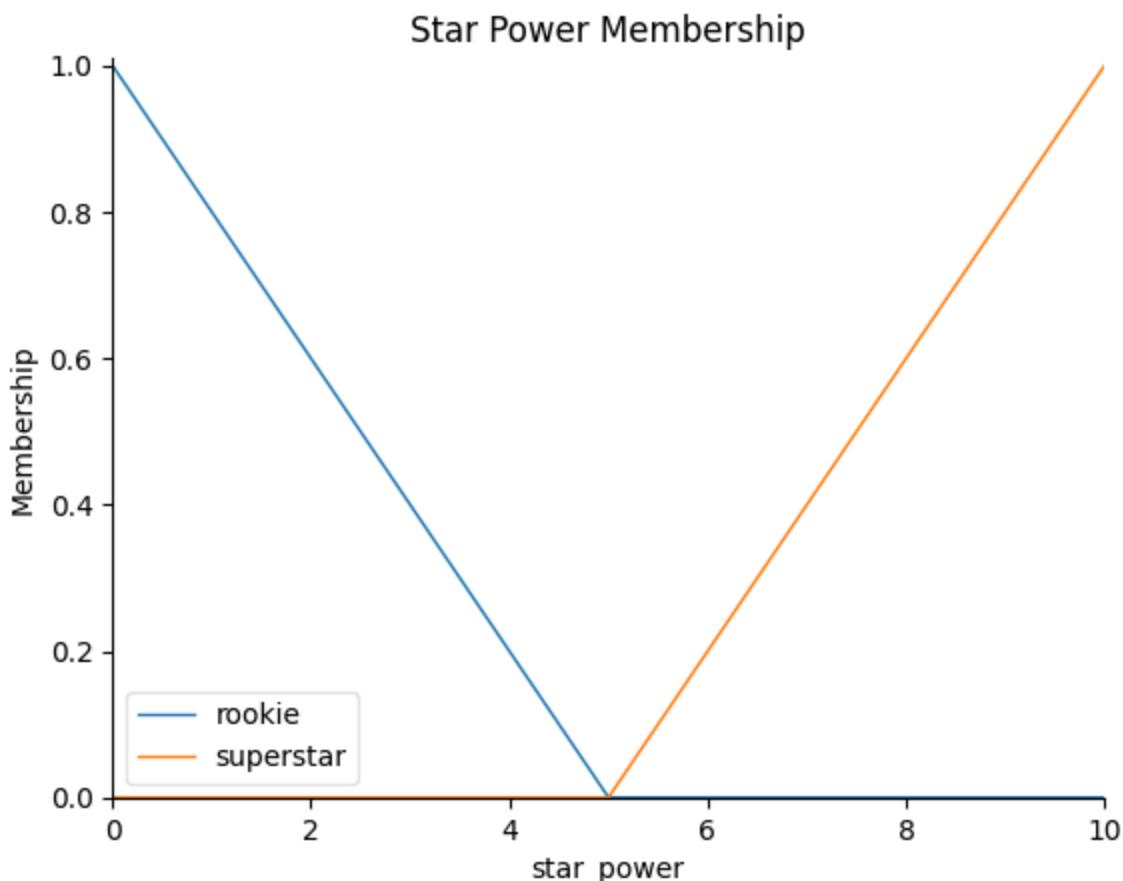
anticipation['boring'] = skfuzzy.trimf(anticipation_range, [0, 0, 5])
anticipation['average'] = skfuzzy.trimf(anticipation_range, [3, 5, 7])
anticipation['must_see'] = skfuzzy.trimf(anticipation_range, [5, 10, 10])
```

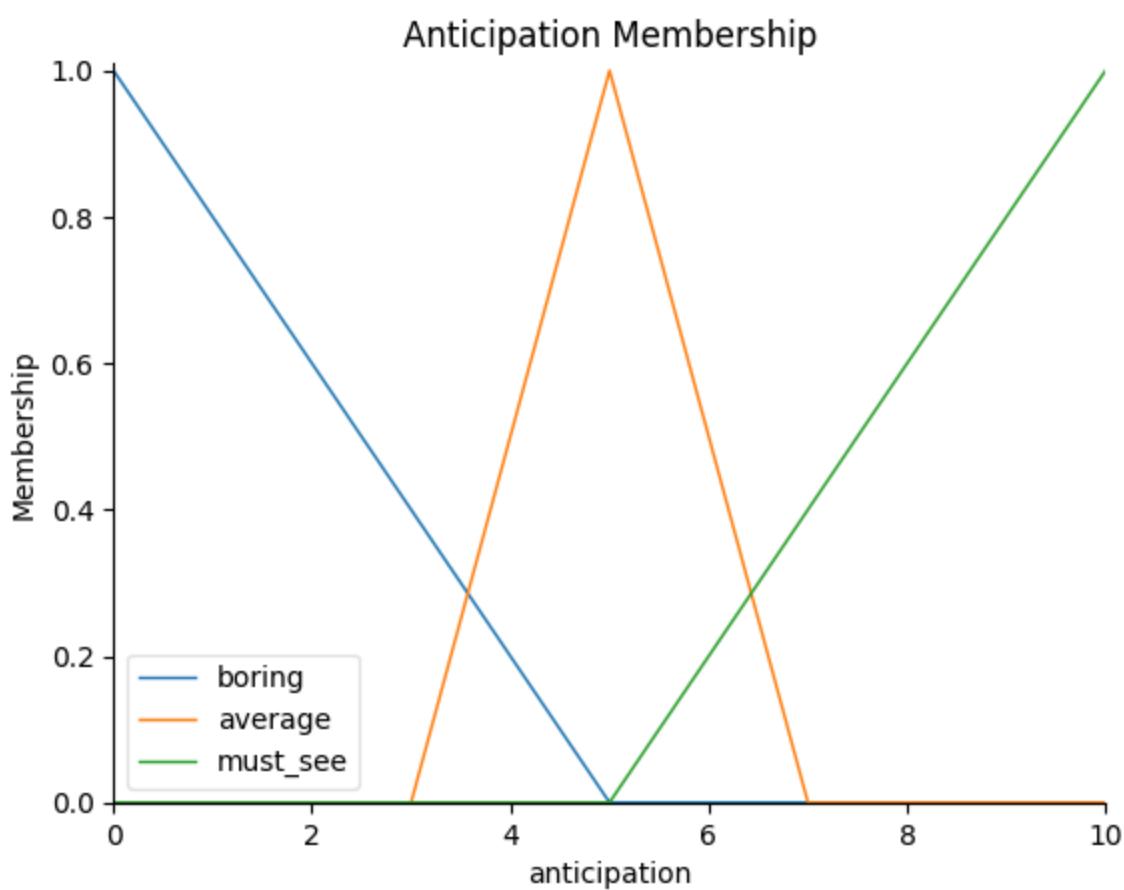
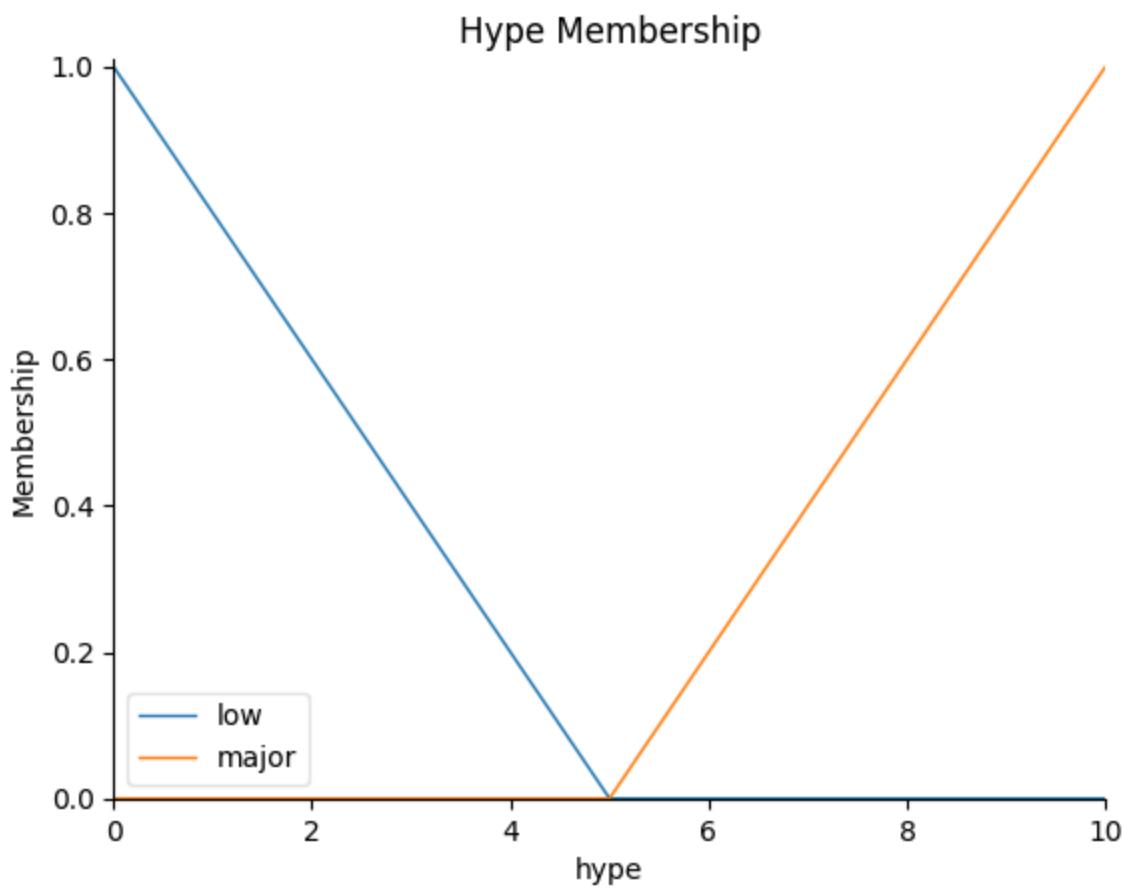
Step 4: Visualize Membership Functions

```
In [15]: star_power.view()
plt.title('Star Power Membership')
plt.show()

hype.view()
plt.title('Hype Membership')
plt.show()

anticipation.view()
plt.title('Anticipation Membership')
plt.show()
```





Step 5: Establish Fuzzy Decision Rules

```
In [10]: rules = [
    control.Rule(star_power['rookie'] & hype['major'], anticipation['average']),
    control.Rule(star_power['superstar'] & hype['major'], anticipation['must_see']),
    control.Rule(star_power['rookie'] & hype['low'], anticipation['boring']),
    control.Rule(star_power['superstar'] & hype['low'], anticipation['average']),
]
```

Step 6: Construct and Configure Fuzzy Control System

```
In [11]: wwe_system = control.ControlSystem(rules)
wwe_simulator = control.ControlSystemSimulation(wwe_system)
```

Step 7: Input Crisp Values for Inference

```
In [12]: test_star_power = 9 # Example: very high star power
test_hype = 3 # Example: low/medium hype
wwe_simulator.input['star_power'] = test_star_power
wwe_simulator.input['hype'] = test_hype
print(f'Step 7: Entered values -> Star Power: {test_star_power}, Hype: {test_hype}'
```

Step 7: Entered values -> Star Power: 9, Hype: 3

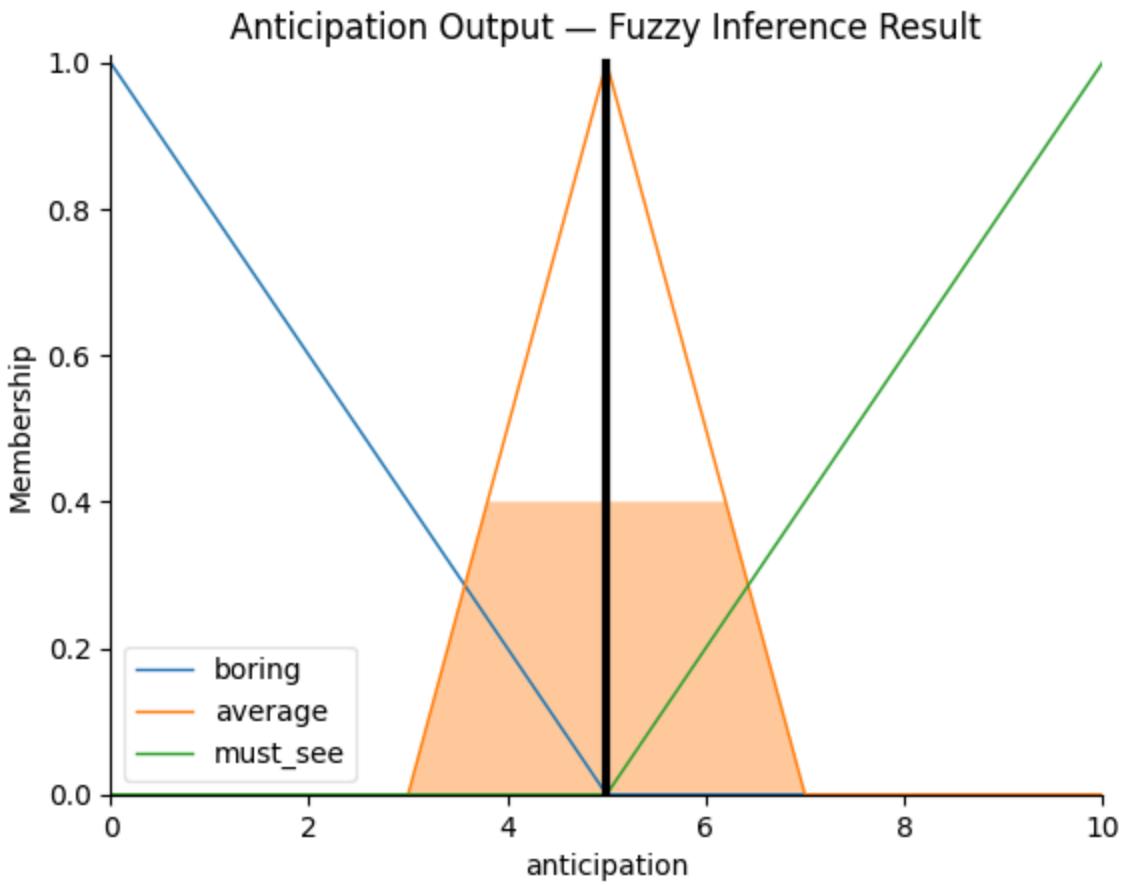
Step 8: Perform Fuzzy Inference and Compute Output

```
In [13]: wwe_simulator.compute()
final_anticipation = wwe_simulator.output['anticipation']
print(f'Step 8: Output value (Anticipation): {final_anticipation:.2f} (Range: 0=boring to 10=must see)')
```

Step 8: Output value (Anticipation): 5.00 (Range: 0=boring, 10=must see)

Step 9: Visualize Defuzzified Output and Fuzzy Set

```
In [14]: anticipation.view(sim=wwe_simulator)
plt.title('Anticipation Output - Fuzzy Inference Result')
plt.show()
```



Conclusion

In this lab, we implemented a fuzzy logic inference system to model decision-making under uncertainty using two input variables star power and hype to predict the anticipation level for a WWE wrestling match. The process began with defining suitable membership functions for each variable, establishing a set of IF-THEN rules based on domain knowledge, and then carrying out fuzzification, rule evaluation, aggregation, and defuzzification.

The results demonstrated that fuzzy logic provides a systematic method for translating qualitative human reasoning into quantitative outputs. By employing fuzzy sets, the system can handle vagueness in linguistic categories such as "superstar," "major hype," or "must see," and process these to yield a crisp, interpretable decision score. Visualization of both membership functions and the final inferred output further clarified how different input conditions affect the results.

Overall, this experiment confirms that fuzzy logic systems are effective tools for modeling subjective judgments and making robust decisions in cases where input data or rules are inherently imprecise.

```
In [ ]: !jupyter nbconvert --to webpdf "D:/Github/Data-Science-And-Machine-Learning-Course/
```

