INTE 22303 - Artificial Intelligence

Fuzzy Logic Systems applied on a Tipping Agent

Group members

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Link to the Google Colaboratory

https://colab.research.google.com/drive/1kbx3qFGFE969E8VQNfuuYJtWvBb3PBvg?usp=sharing

Source Code

```python
import skfuzzy as fuzz
from skfuzzy import control as ctrl
import matplotlib.pyplot as plt

# Define the input variables
service = ctrl.Antecedent(np.arange(0, 11, 1), 'service')
quality = ctrl.Antecedent(np.arange(0, 11, 1), 'quality')

# Define the output variable
tip = ctrl.Consequent(np.arange(0, 26, 1), 'tip')

# Create the membership functions
service['poor'] = fuzz.trimf(service.universe, [0, 0, 5])
service['average'] = fuzz.trimf(service.universe, [0, 5, 10])
service['excellent'] = fuzz.trimf(service.universe, [5, 10, 10])

quality['poor'] = fuzz.trimf(quality.universe, [0, 0, 5])
quality['average'] = fuzz.trimf(quality.universe, [0, 5, 10])
quality['excellent'] = fuzz.trimf(quality.universe, [5, 10, 10])

tip['low'] = fuzz.trimf(tip.universe, [0, 0, 12.5])
tip['medium'] = fuzz.trimf(tip.universe, [0, 12.5, 25])
tip['high'] = fuzz.trimf(tip.universe, [12.5, 25, 25])

# Define the rules
rule1 = ctrl.Rule(service['poor'] | quality['poor'], tip['low'])
rule2 = ctrl.Rule(service['average'] | quality['average'], tip['medium'])
rule3 = ctrl.Rule(service['excellent'] | quality['excellent'], tip['high']
)

# Create the control system
tip_ctrl = ctrl.ControlSystem([rule1, rule2, rule3])
tip_simulator = ctrl.ControlSystemSimulation(tip_ctrl)

# Prompt user for input values
s = input("Enter service rating (0-10): ")
q = input("Enter food quality rating (0-10): ")

# Convert input strings to floats
service_val = float(s)
```

```
quality_val = float(q)

# Run the simulation with user inputs
tip_simulator.input['service'] = service_val
tip_simulator.input['quality'] = quality_val

tip_simulator.compute()
print("Tip percentage: ", tip_simulator.output['tip'],"% \n")

# Plot the membership functions for service
service.view()

# Plot the membership functions for quality
quality.view()

# Plot the membership functions for tip
tip.view()

plt.show()
```

Tipping Agent

Here the tipping agent consists of a set of fuzzy rules and membership functions. The tipping agent determines which outcome is provided, given the input variables. The decision boundary can be set based on the analysis of how it can be constrained into the relevant scenario. Here, the decision boundary has set on the values given for taking the decision of 'poor', 'average', 'excellent' of the 'service' and 'food quality'.

Code Explanation

Libraries

These main two libraries provide tools for creating and training fuzzy control systems. It includes classes for defining input and output variables, membership functions, and fuzzy rules, as well as it functions based on user input values.

Inputs and Outputs

The program defines two input variables, "service" and "quality". Quality represents the quality of the food that is rated by the customer. While the one output variable generates the "tip".

Membership functions

The membership functions for each input and output variable are defined using the fuzz.trimf() function from the skfuzzy library. The trimf() function creates a triangular membership function for the given range of values. For the input variables "service" and "quality", three membership functions are defined, "poor", "average", and "excellent". For the output variable "tip", three membership functions are also defined, "low", "medium", and "high". These functions represent different boundary values divided into three parts.

(service['poor'] = fuzz.trimf(service.universe, [0, 0, 5])

Rules

Rule 1 states that if the service is 'poor' OR the quality is 'poor', then the tip should be 'low'. Rule 2 states that if the service is 'average' OR the quality is 'average', then the tip should be 'medium'. Rule 3 applies where both the service and quality are 'excellent', then the tip must be 'higher'.

Control systems and run simulation

The control system includes three rules, which determine the tip percentage based on the service and food quality ratings provided by the user. This is used to create a simulation which takes the user's input ratings and give output as the tip percentage

After defining the control system, the program creates the user for input values for the service and quality ratings. The user inputs are then used to run the simulation using the "ControlSystemSimulation" class.

Plot

Finally, the program uses the view function to plot the membership functions for each input and output variable. The show function is used to display the plot.