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H041

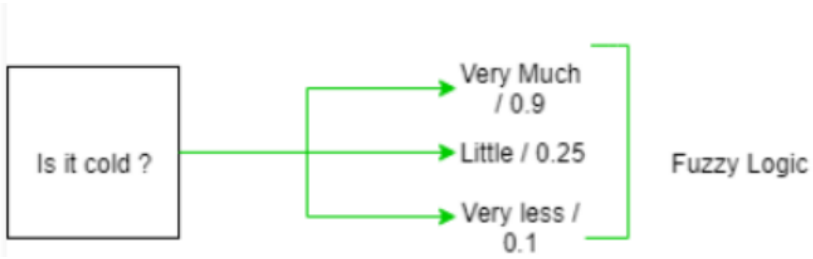
Lab 8

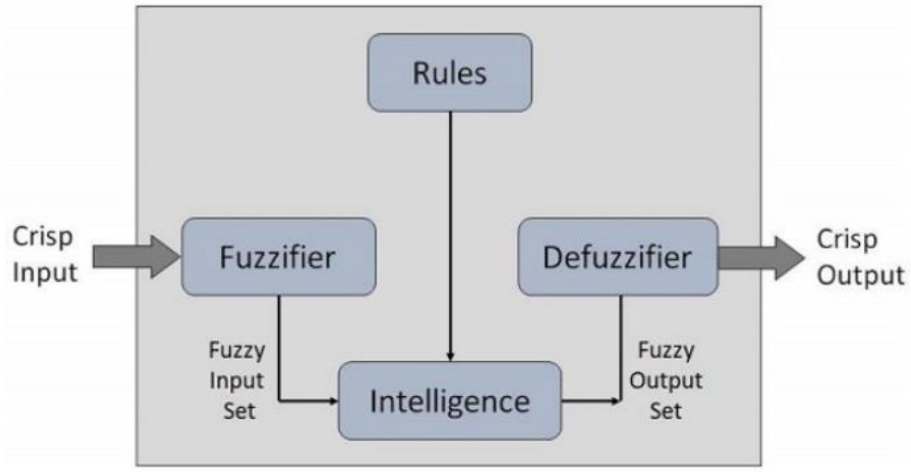
AIM: To study and implement Fuzzy Inference System using Python.

Software: Google Colab (using skfuzzy library)

Theory:

The term **FUZZY** refers to things which are not clear or are vague. In the real world many times we encounter a situation when we can't determine whether the state is true or false, their fuzzy logic provides a very valuable flexibility for reasoning. In this way, we can consider the inaccuracies and uncertainties of any situation. In Boolean system truth value, 1.0 represents absolute truth value and 0.0 represents absolute false value. But in the fuzzy system, there is no logic for absolute truth and absolute false value. But in fuzzy logic, there is intermediate value too present which is partially true and partially false.





Fuzzification: It is the method of transforming a crisp quantity into a fuzzy quantity. This can be achieved by identifying the various known crisp and deterministic quantities as completely nondeterministic and quite uncertain in nature. This uncertainty may have emerged because of vagueness and imprecision which then lead the variables to be represented by a membership function as they can be fuzzy in nature. For example, when I say the temperature is 45° Celsius the

viewer converts the crisp input value into a linguistic variable like favourable temperature for the human body, hot or cold.

Defuzzification: It is the inversion of fuzzification, there the mapping is done to convert the crisp results into fuzzy results but here the mapping is done to convert the fuzzy results into crisp results. This process is capable of generating a nonfuzzy control action which illustrates the possibility distribution of an inferred fuzzy control action. Defuzzification process can also be treated as the rounding off process, where fuzzy set having a group of membership values on the unit interval reduced to a single scalar quantity.

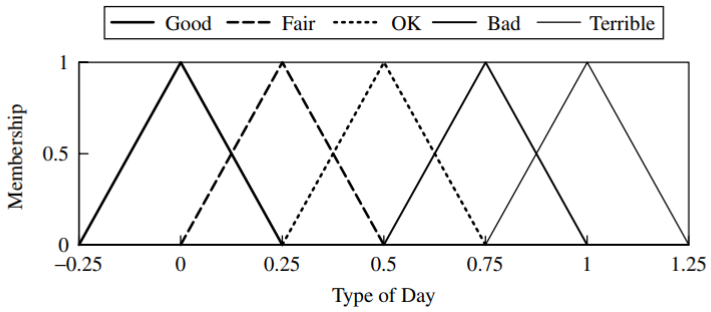
Fuzzy Knowledge Base: It stores the knowledge about all the input-output fuzzy relationships. It also has the membership function which defines the input variables to the fuzzy rule base and the output variables to the plant under control.

Fuzzy Rule Base: It stores the knowledge about the operation of the process of domain.

Inference Engine: It acts as a kernel of any FLC. Basically, it simulates human decisions by performing approximate reasoning.

Membership Functions:

- Membership functions allow you to quantify linguistic term and represent a fuzzy set graphically. A membership function for a fuzzy set A on the universe of discourse X is defined as μA:X → [0,1].
- Here, each element of X is mapped to a value between 0 and 1. It is called membership value or degree of membership. It quantifies the degree of membership of the element in X to the fuzzy set A.



Code:

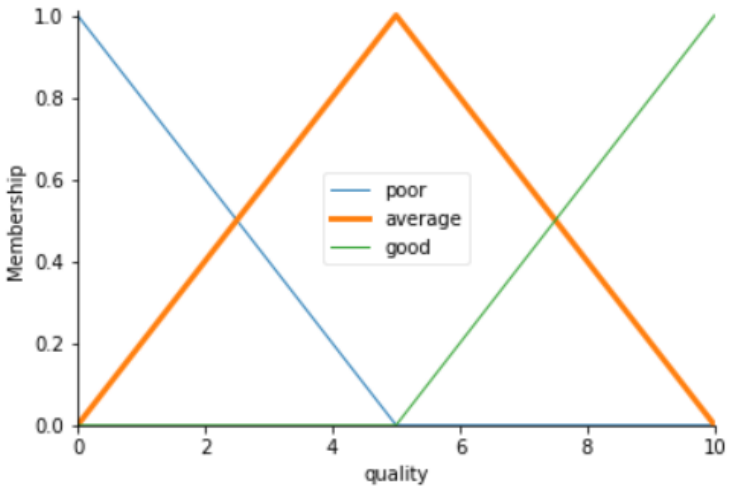
```
!pip install scikit-fuzzy
```

```
import numpy as np
import skfuzzy as fuzz
```

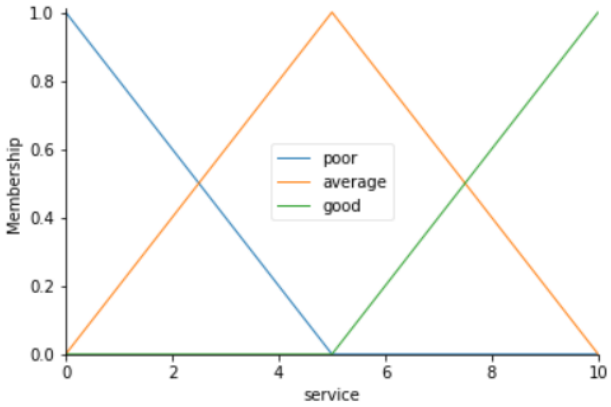
```
from skfuzzy import control as ctrl

quality = ctrl.Antecedent(np.arange(0, 11, 1), 'quality')
service = ctrl.Antecedent(np.arange(0, 11, 1), 'service')
tip = ctrl.Consequent(np.arange(0, 26, 1), 'tip')

quality.automf(3)
service.automf(3)

tip['low'] = fuzz.trimf(tip.universe, [0, 0, 13])
tip['medium'] = fuzz.trimf(tip.universe, [0, 13, 25])
tip['high'] = fuzz.trimf(tip.universe, [13, 25, 25])

quality['average'].view()
service.view()
tip.view()

rule1 = ctrl.Rule(quality['poor'] & service['poor'], tip['low'])
rule1.view()
rule2 = ctrl.Rule(quality['average'] & service['average'], tip['medium'
])
rule3 = ctrl.Rule(quality['good'] & service['good'], tip['high'])

tipping_ctrl = ctrl.ControlSystem({rule1, rule2, rule3})
tipping = ctrl.ControlSystemSimulation(tipping_ctrl)

while True:
    tipping.input['quality'] = float(input('How much would you like to
give us out of 10 for the quality of food? '))
    tipping.input['service'] = float(input('How much would you like to
give us out of 10 for the service? '))
    tipping.compute()
    print(f"Your approximate tip will be: {tipping.output['tip']}")
    tip.view(sim=tipping)
    break
```

Output:

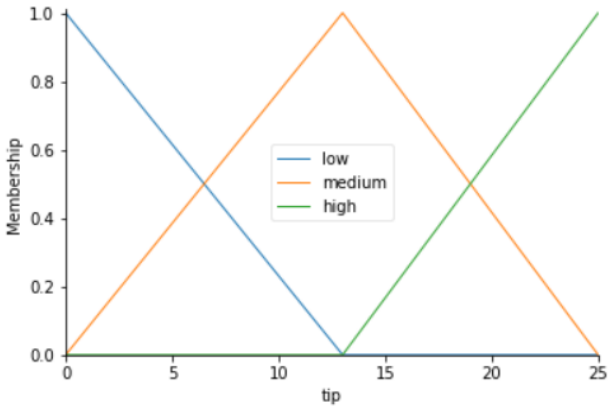
```
quality['average'].view()
```



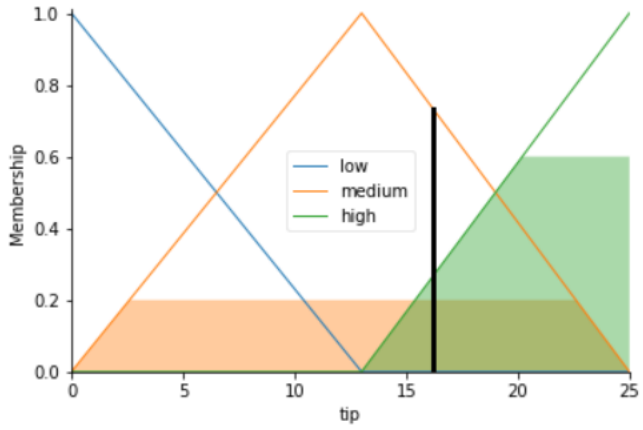

```
[9] service.view()
```




```
tip.view()
```



```
How much would you like to give us out of 10 for the quality of food? 9
How much would you like to give us out of 10 for the service? 8
Your approximate tip will be: 16.2 %
```



Conclusion: In this experiment we have created a restaurant tip calculator with 25% of the bill being the maximum, using Fuzzy Logic. Depending on the input parameters of Quality and Service, we calculate the desired percentage of tip.

Reference links:

- **https://towardsdatascience.com/fuzzy-inference-system-implementation-in-python-8af88d1f0a6e**
- (302) FUZZY FUZZIFICATION DEFUZZIFICATION CODING IN PYTHON IN JUST 9 MINUTE #python SOFT COMPUTING - YouTube