الجمهورية العربية السورية
جامعة دمشق
كلية الهندسة المعلوماتية
السنة الخامسة

Fuzzy Logic proejct Report

Diagnosing a patient's mental health condition

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Introduction

To develop a Fuzzy Expert System for diagnosing a patient's mental health condition, we will use Python and the scikit-fuzzy library. The system will take input variables such as behavior, speech, and medical history and output a diagnosis based on fuzzy logic. The system will consist of the following components:

1. Fuzzy Sets: fuzzy sets for each input variable, using the scikit-fuzzy library.
2. Membership Functions: membership functions for each fuzzy set.
3. Rule Base: rule base with at least 5 rules, using if-then statements.
4. Inference Engine: implement the inference engine using the Mamdani method.
5. Defuzzification.
6. User Interface: a simple UI using tkinter that allows users to input behavior, speech, and medical history and receive a diagnosis.

Fuzzy system

Input variables:

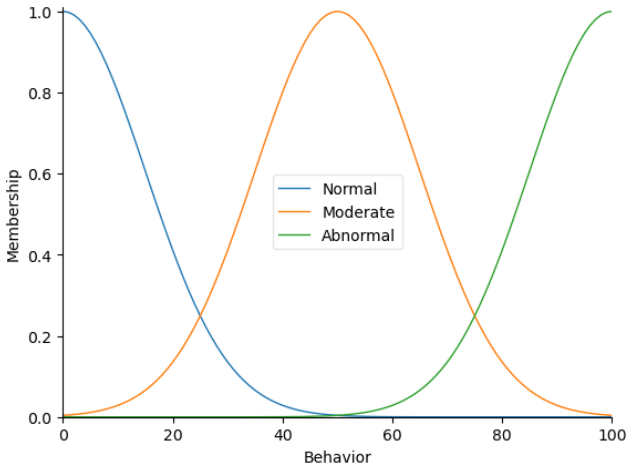
1. Behavior: [0 , 100]
2. Speech: [0 , 100]
3. Medical_history: [0 , 100]

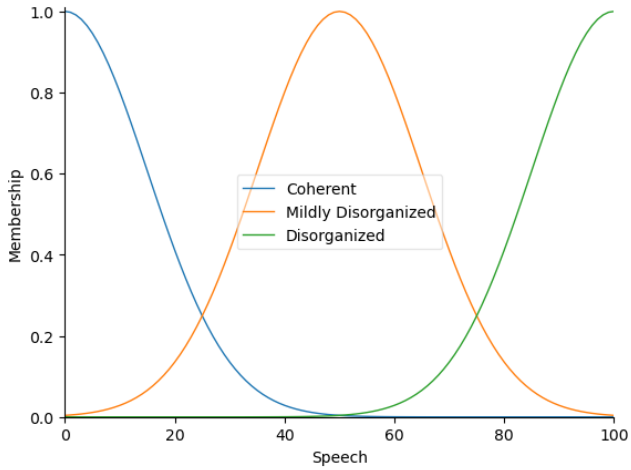
Output variables:

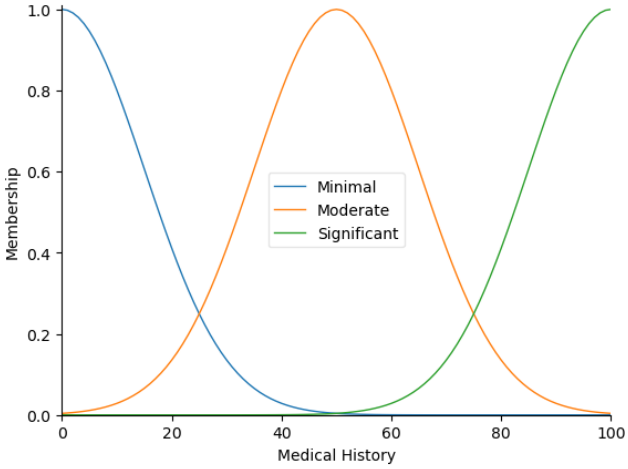
1. Medical_health_condition: [0 , 100]

Membership functions:

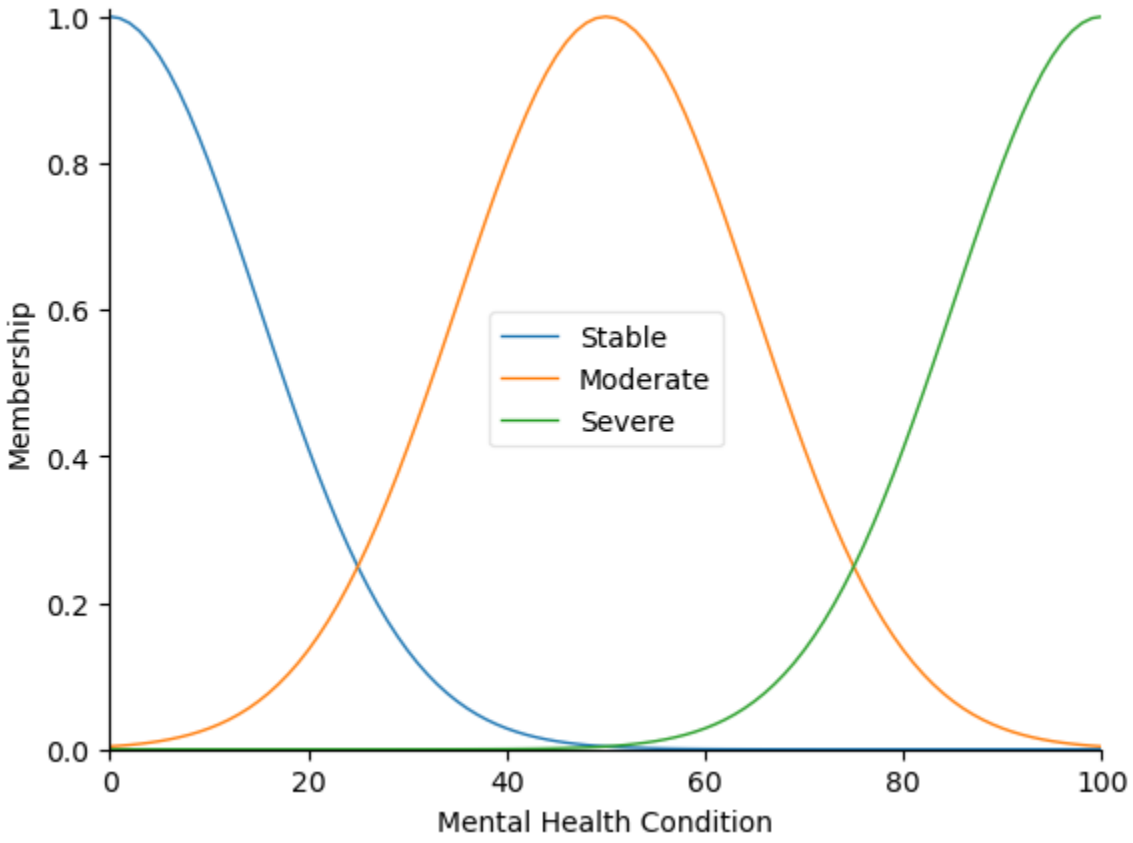
1. Behavior: consists of three membership functions:
    a. Normal: Gaussian membership function with mean of: 0, and standard deviation of: 15.
    b. Moderate: Gaussian membership function with mean of: 50, and standard deviation of: 15.
    c. Abnormal: Gaussian membership function with mean of: 100, and standard deviation of: 15.
2. Speech: consists of three membership functions:
    a. Coherent: Gaussian membership function with mean of: 0, and standard deviation of: 15.
    b. Mildly Disorganized: Gaussian membership function with mean of: 50, and standard deviation of: 15.
    c. Disorganized: Gaussian membership function with mean of: 100, and standard deviation of: 15.
3. Medical_history: consists of three membership functions:
    a. Minimal: Gaussian membership function with mean of: 0, and standard deviation of: 15.
    b. Moderate: Gaussian membership function with mean of: 50, and standard deviation of: 15.
    c. Significant: Gaussian membership function with mean of: 100, and standard deviation of: 15.







4. Mental_health_condition: consists of three membership functions:
    a. Stable: Gaussian membership function with mean of: 0, and standard deviation of: 15.
    b. Moderate: Gaussian membership function with mean of: 50, and standard deviation of: 15.
    c. Serve: Gaussian membership function with mean of: 100, and standard deviation of: 15.



Fuzzy Rules:

1. If Behavior is Normal and Speech is Coherent and Medical History is Minimal, then Mental Health Condition is Stable.
2. If Behavior is Abnormal or Speech is Disorganized, then Mental Health Condition is Severe.
3. If Medical History is Significant and (Behavior is Moderate or Speech is Mildly Disorganized), then Mental Health Condition is Severe.
4. If Behavior is Moderate and Speech is Mildly Disorganized and Medical History is Moderate, then Mental Health Condition is Moderate.
5. If Behavior is Normal and (Speech is Coherent or Medical History is Minimal), then Mental Health Condition is Stable.

Inference Engine:

We use the Mamdani method as an inference engine. The inference engine will take the inputs and use the rules to determine the output. We will use the scikit-fuzzy library to implement the inference engine.

Defuzzification:

we use the centroid method for defuzzification step. The defuzzification method will take the fuzzy output and convert it to a crisp value.

Categorize the result

As the output variable (Mental health condition) is a crisp number we use a simple map function to map each crisp value to a categorical value:

If crispValue <= 33 then the mental health is Stable.

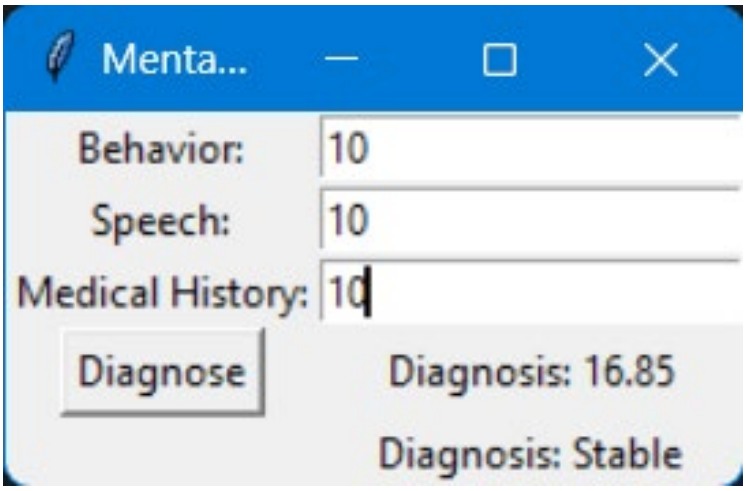
elif crispValue <= 66 then the mental health is Moderate.

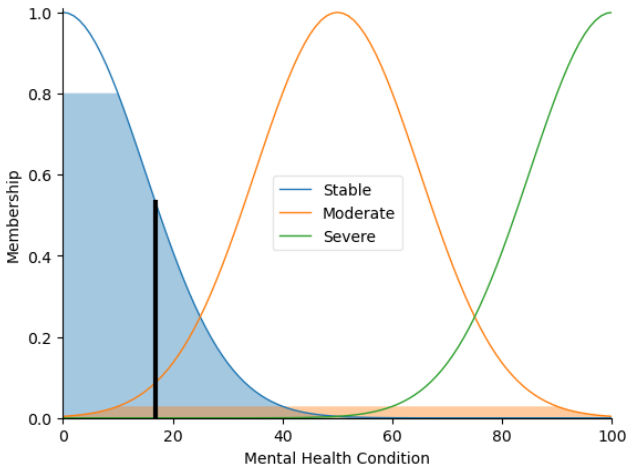
else crispValue <= 33 then the mental health is Severe

Example

Inputs: Behavior = 10 , Speech = 10 , Medical History = 10

Result: crisp value = 16.85 (Stable)





Testing and Validation:

We test the fuzzy system with simple dataset:

Behavior	Speech	Medical History	Expected Mental Health Condition
Normal	Coherent	Minimal	Stable
Abnormal	Disorganized	Significant	Severe
Moderate	Mildly Disorganized	Moderate	Moderate
Normal	Mildly Disorganized	Significant	Severe
Abnormal	Coherent	Minimal	Severe
Moderate	Coherent	Significant	Severe
Normal	Coherent	Moderate	Moderate
Abnormal	Disorganized	Significant	Severe
Moderate	Mildly Disorganized	Minimal	Stable
Normal	Coherent	Significant	Moderate

we map the input variables from categorical values to numerical values using a randomness technique corresponding to each field of the input variables:

Behavior:

a. Normal: random(0,10)
b. Moderate: random(40 , 60)
c. Abnormal: random (90-100)

Speech:

a. Coherent: random(0,10)
b. Mildly Disorganized: random(40,60)
c. Disorganized: random(90,100)

Medical History:

a. Minimal: random(0,10)
b. Moderate: random(40,60)
c. Significant: random(90,100)

Then we calculate the crisp output using the fuzzy system and map it to categorical shape as descript in (Categorize the result) section.

We got Accuracy of: 0.7 (70%) and Precision of 1.0 (100%) in the Severe class.

Note: this type of problems when we diagnostic a medical situation we care a lot about the presession because if we give wrong diagnostic about a positive situation this will cost the patient a lot in the future.

Deployment

We save the fuzzy system as a pickle file so we can load it anywhere and use it without redefining the inputs, outputs and rules.