

Syrian Arab Republic

ITE Damascus University

AI Specialization – 5<sup>th</sup> Grade



# **Fuzzy Logic Project Report**

## **Weather Condition System Predictor**

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## Table of Contents

<b>1. Problem Statement:</b> .....	2
<b>2. Fuzzy Sets and Membership Functions:</b> .....	2
<b>2.1 Fuzzy Input Variables:</b> .....	2
<b>2.2 Fuzzy Output Variables:</b> .....	8
<b>3. Rule Base:</b> .....	9
<b>4. Inference Engine:</b> .....	13
<b>5. Defuzzification:</b> .....	13
<b>6. System Implementation and User Guide:</b> .....	14
<b>7. Testing and Validation:</b> .....	16
<b>8. References:</b> .....	16

## 1. Problem Statement:

A weather prediction system for a region prone to sudden weather changes.

The system should accurately predict the weather conditions for the next 24 hours based on historical weather data and current atmospheric conditions.

The predictions should include categories such as clear, partly cloudy, mostly cloudy, overcast, light rain, moderate rain, heavy rain, thunderstorm, snow, and fog.

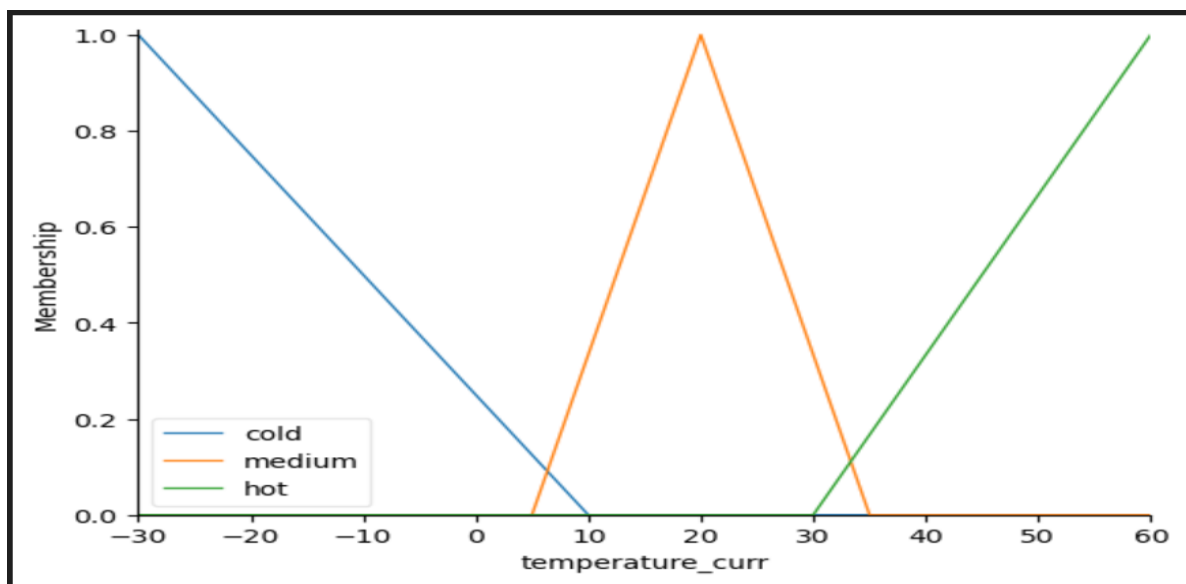
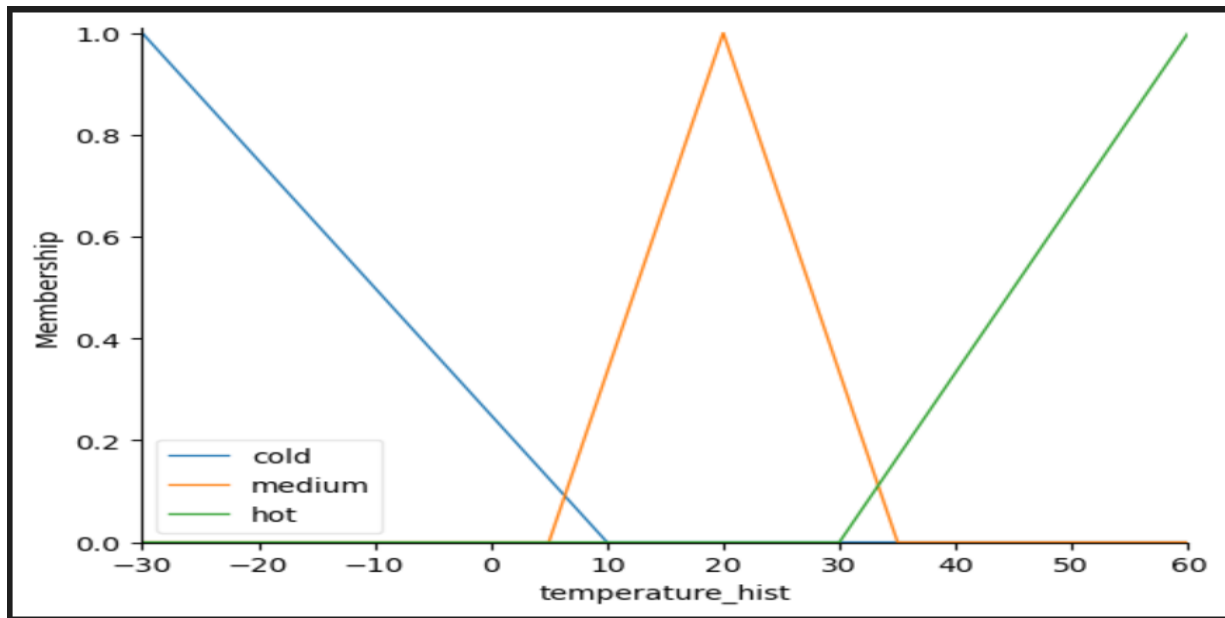
## 2. Fuzzy Sets and Membership Functions:

We used 6 variables for inputs (6 variables for historical and 6 for current), so that makes them 12 variables and the output is 1 variable, and they are:

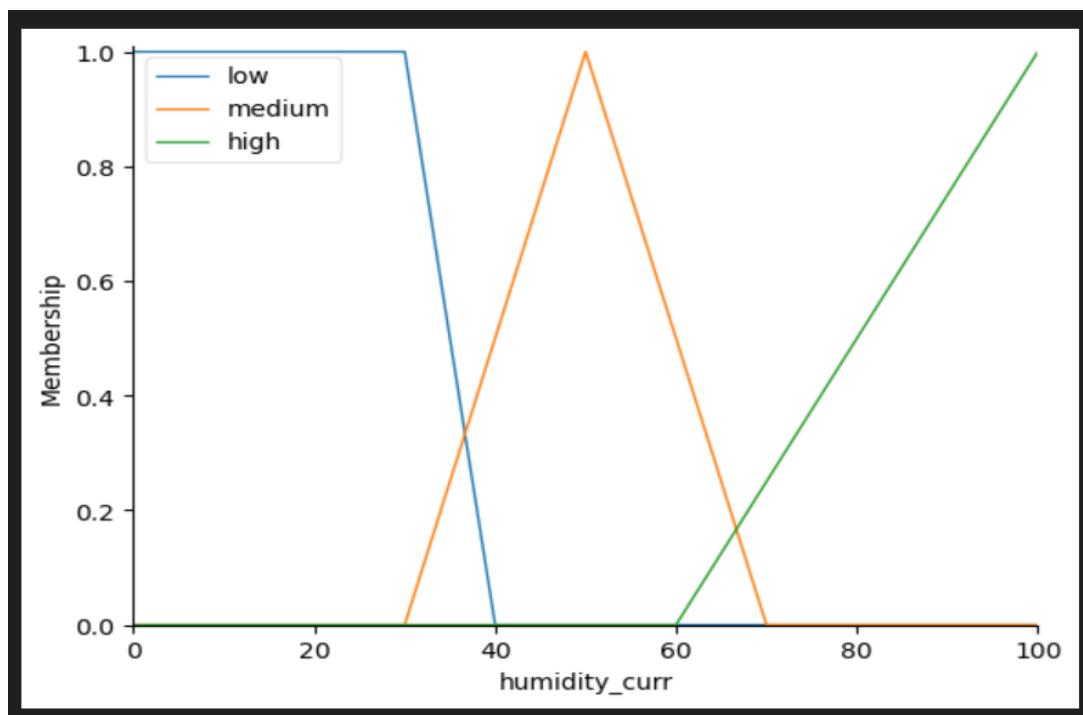
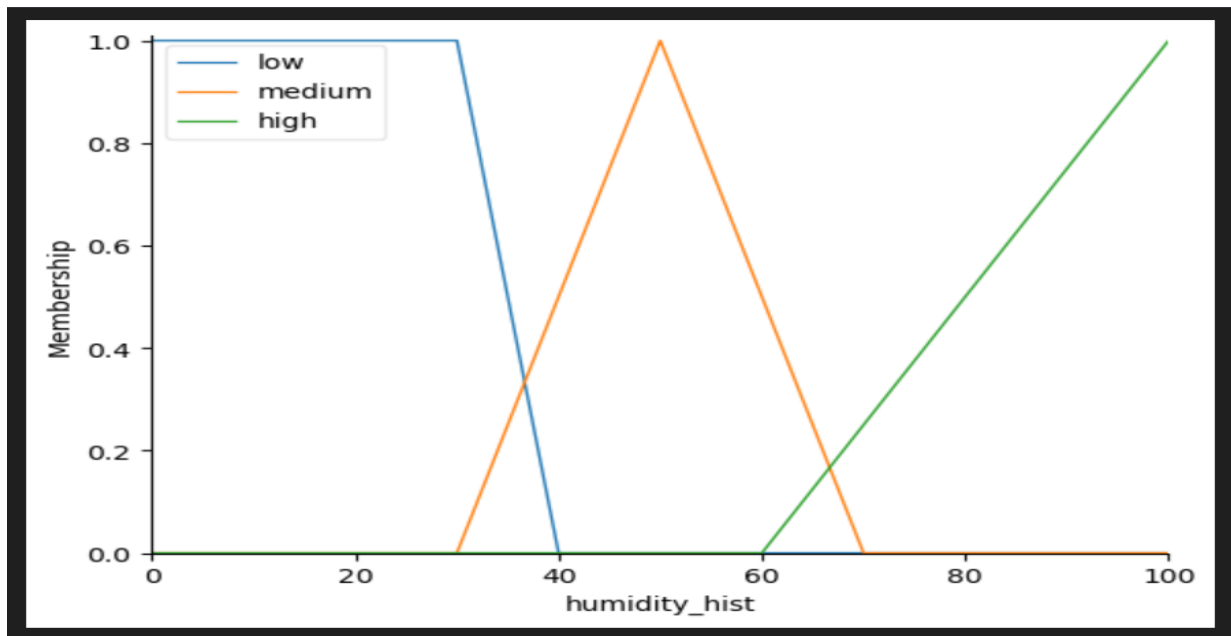
### **2.1 Fuzzy Input Variables:**

- **Temperature:**

The range of this variable vary between -30 to 50 °C for both historical and current.

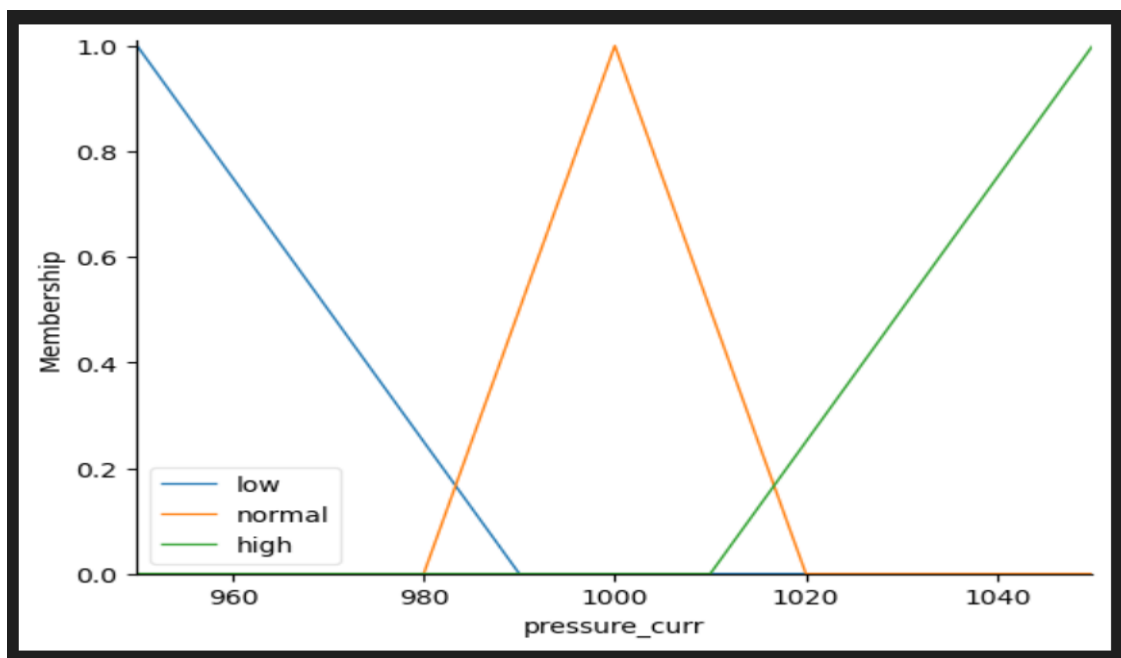
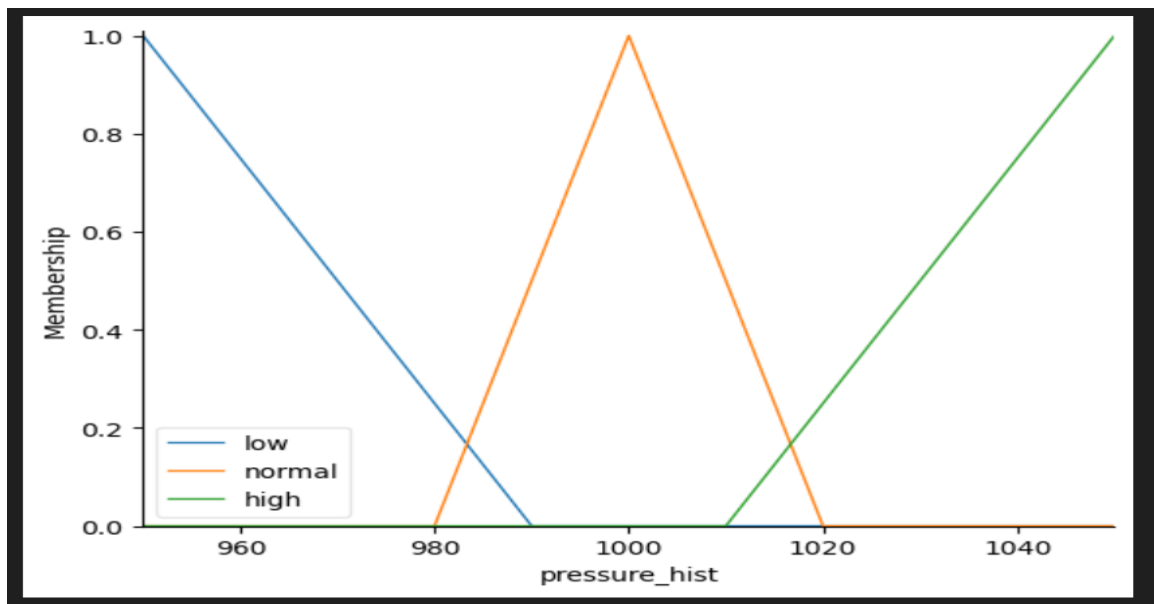


- **humidity:**  
The range of this variable vary between 0 to 100 % for both historical and current.



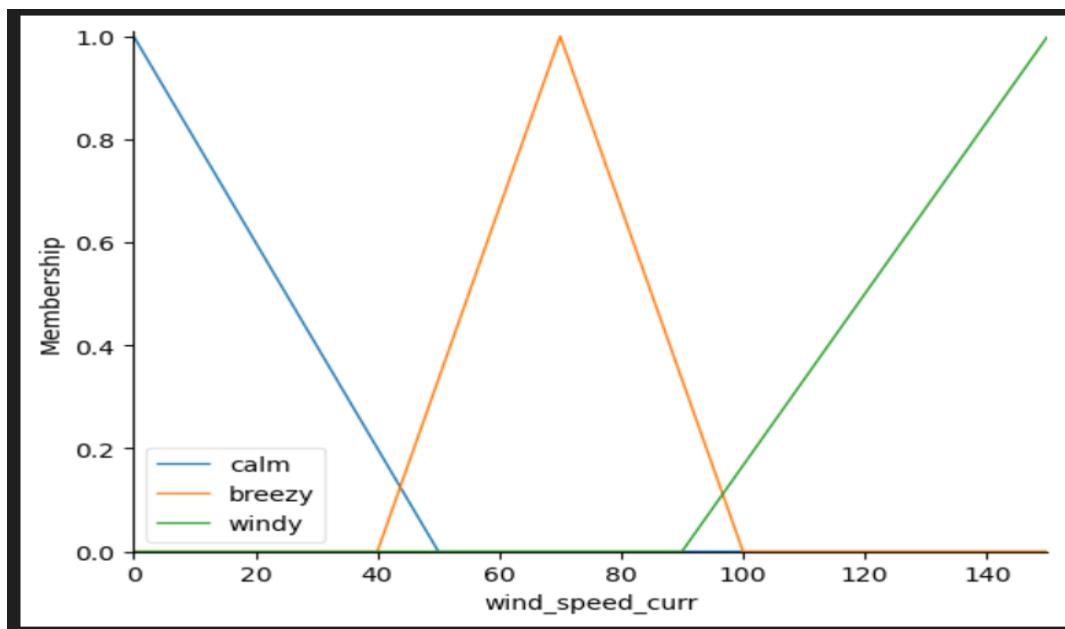
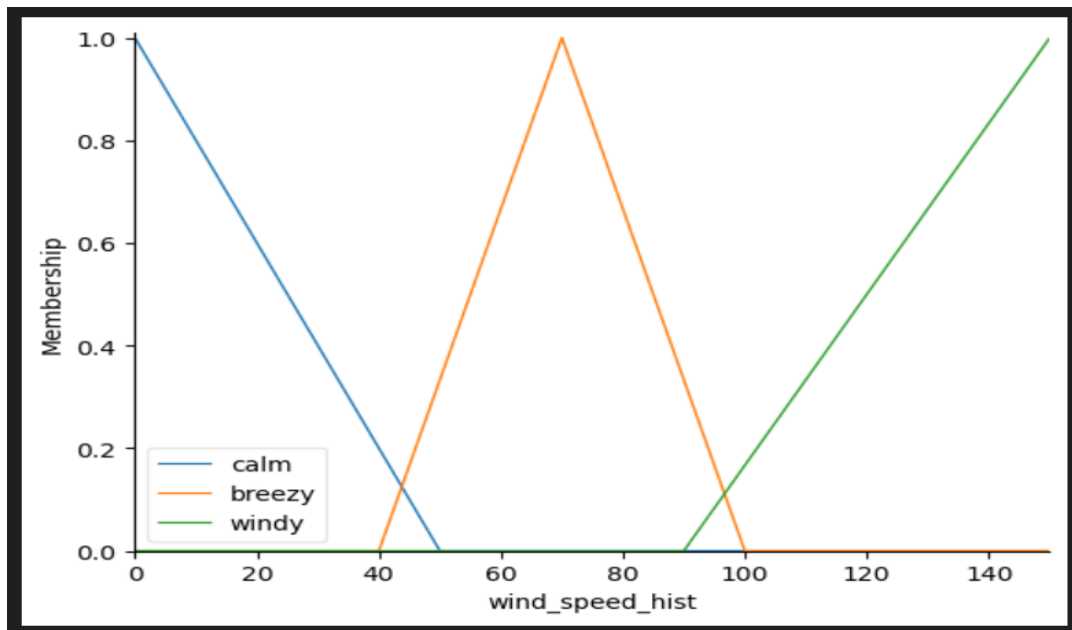
- **Atmospheric Pressure:**

The range of this variable vary between 950 to 1050 hPa for both historical and current.



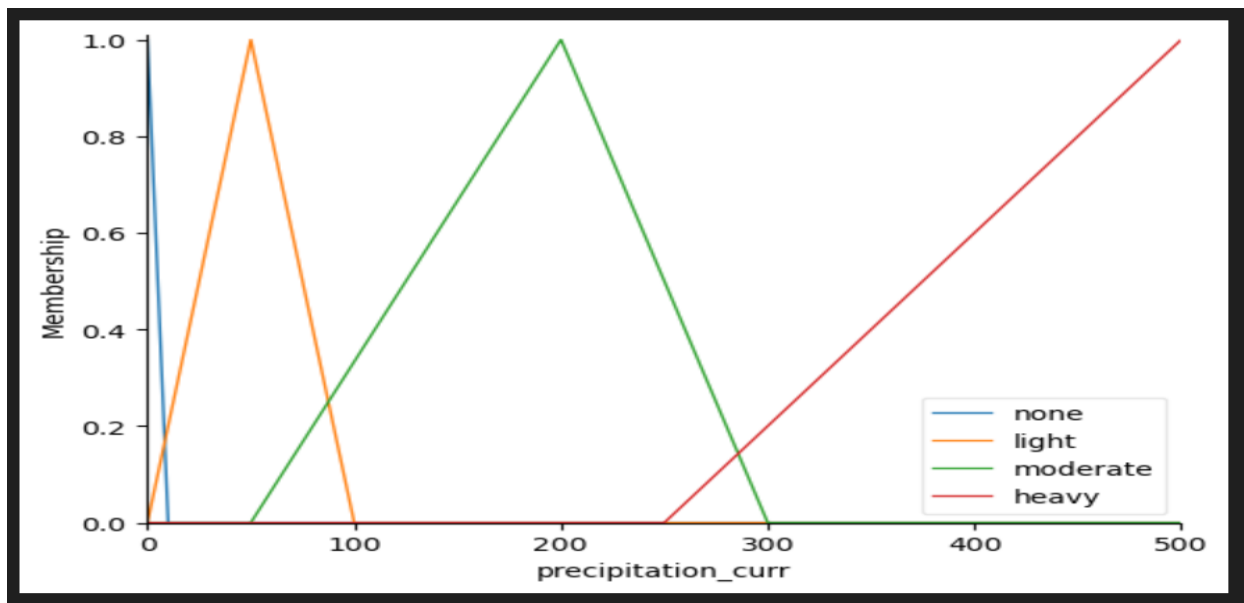
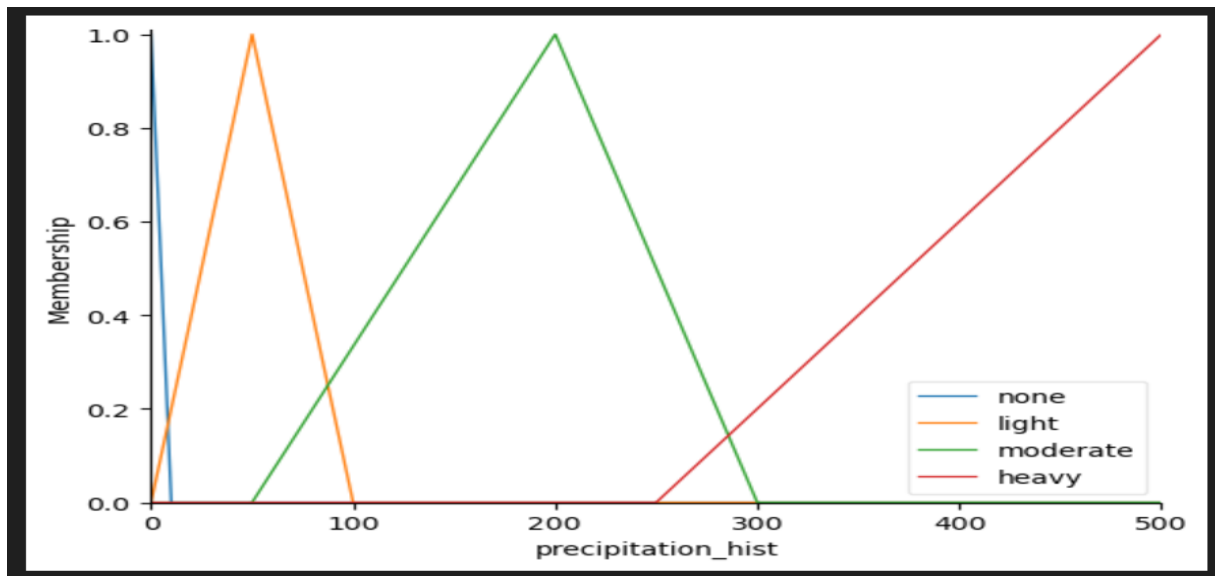
- **Wind Speed:**

The range of this variable vary between 0 to 150 km/h for both historical and current.



- **Precipitation:**

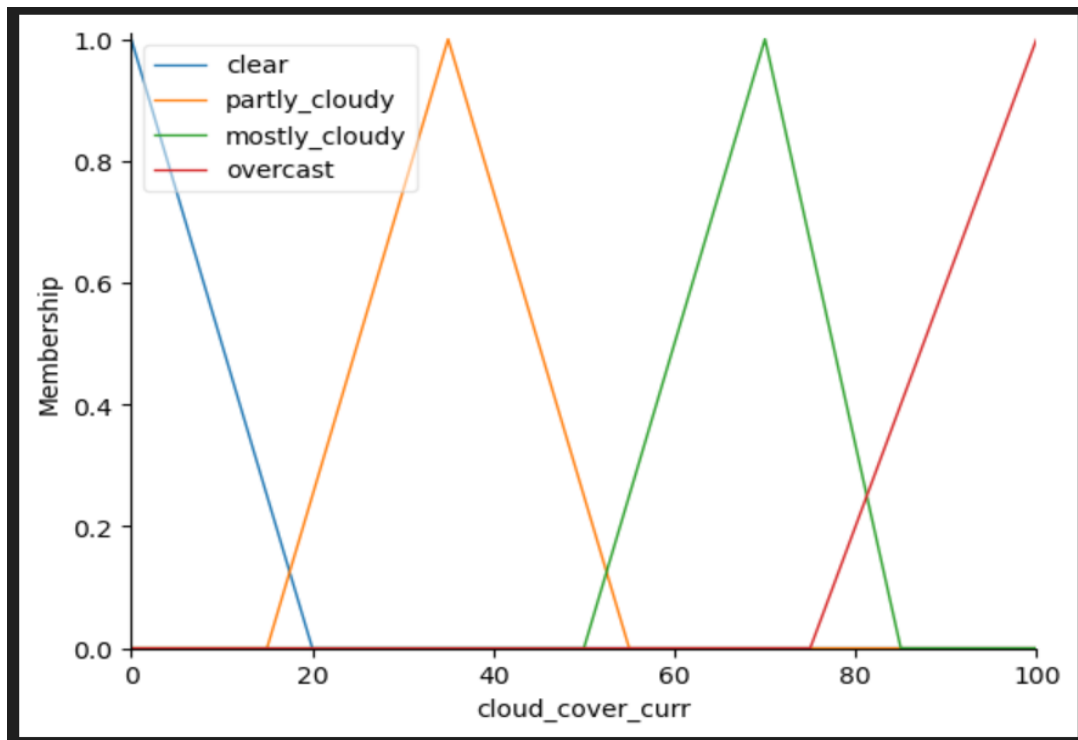
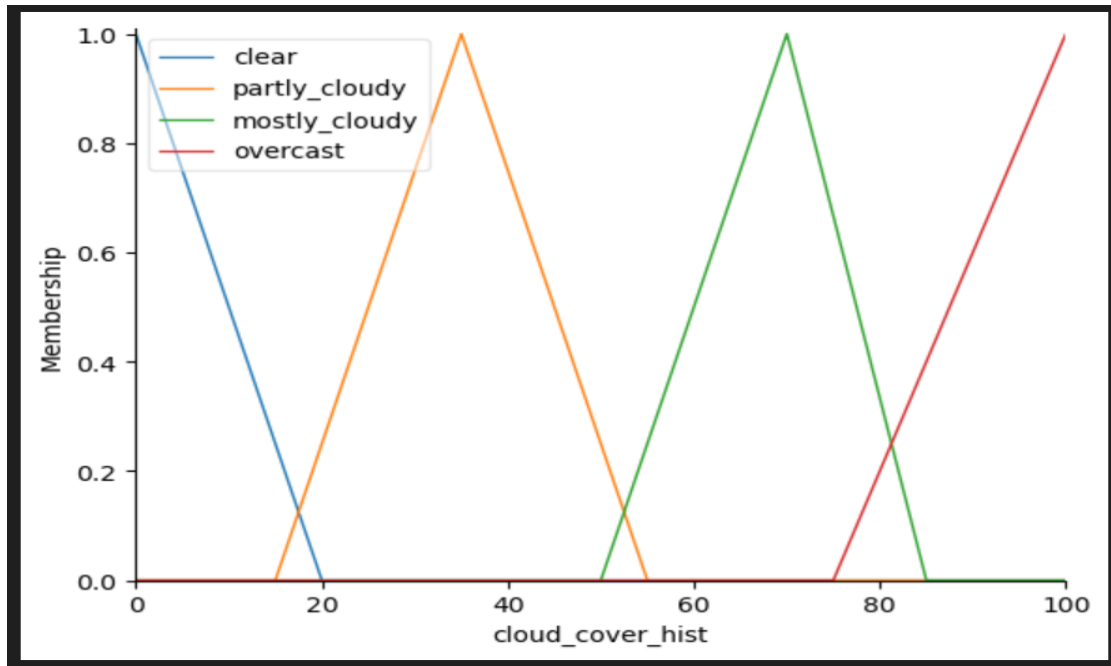
The range of this variable vary between 0 to 500 mm for both historical and current.



- **Cloud Cover:**

The range of this variable vary between 0 to 100 % for both historical and current.

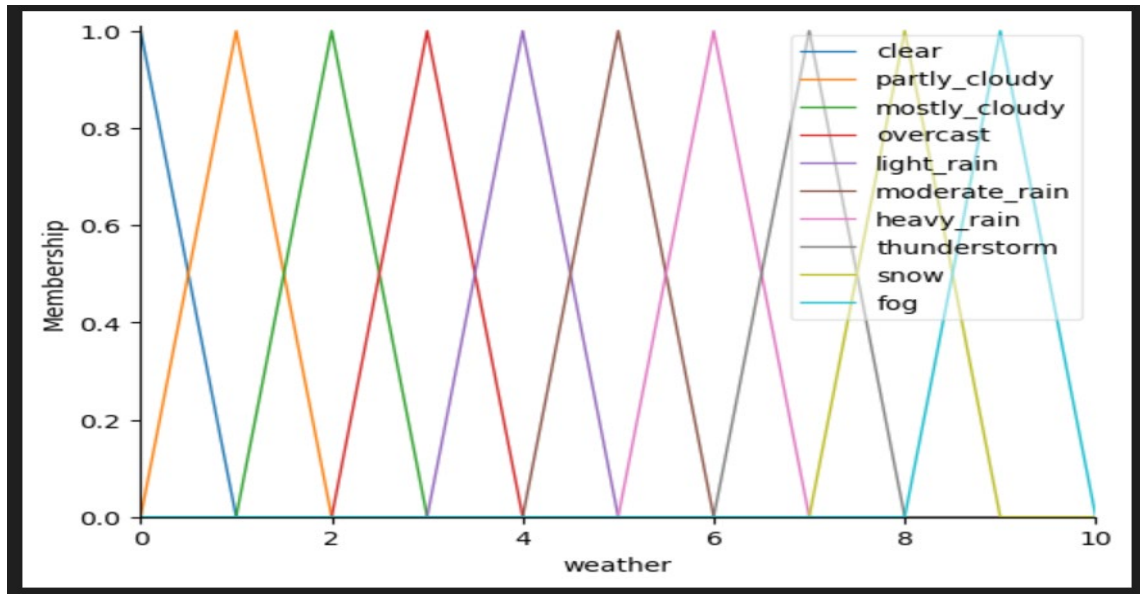




## 2.2 Fuzzy Output Variable:

- **Weather:**

The range of this variable vary between 0 to 10



### 3. Rule Base:

In fuzzy logic, a rule-based system refers to a set of logical statements or rules that govern the behavior of the system. These rules are typically expressed using linguistic variables and fuzzy logic operators.

Rules are formed keeping in mind heuristic relationship between input and output parameters.

This is a summary of all the rules Base that were used in the system (49 Rules)

Weather	temperature hist	humidity hist	pressure hist	wind hist	precipitation hist	cloud hist	temperature curr	humidity curr	pressure curr	wind curr	precipitation curr	cloud curr
overcast				calm		overcast				calm		overcast
overcast		medium				overcast		medium				overcast
overcast			normal			overcast			normal			overcast
overcast	medium					overcast	medium					overcast
light rain					light						light	
moderate rain					moderate						moderate	
heavy rain					heavy						heavy	
snow	cold						cold					
snow	cold					overcast	cold					overcast
snow	cold				light		cold				light	
snow	cold				moderate		cold				moderate	
snow	cold				heavy		cold				heavy	
light rain	medium				light		medium				light	
moderate rain	medium				moderate		medium				moderate	

Weather	temperature hist	humidity hist	pressure hist	wind hist	precipitation hist	cloud hist	temperature curr	humidity curr	pressure curr	wind curr	precipitation curr	cloud curr
partly cloudy	medium	medium	normal			partly cloudy	medium	medium	normal			partly cloudy
clear	hot					clear	hot					clear
fog		high				overcast		high				overcast
clear				calm		clear				calm		clear
clear	medium					clear	medium					clear
clear		medium				clear		medium				clear
clear			normal			clear			normal			clear
clear				calm		clear				calm		clear
clear					none	clear					none	clear
partly cloudy				calm		partly cloudy				calm		partly cloudy
partly cloudy		medium				partly cloudy		medium				partly cloudy
partly cloudy			normal			partly cloudy			normal			partly cloudy
partly cloudy	medium					partly cloudy	medium					partly cloudy

Weather	temperature hist	humidity hist	pressure hist	wind hist	precipitation hist	cloud hist	temperature curr	humidity curr	pressure curr	wind curr	precipitation curr	cloud curr
thunder storm				windy		partly cloudy				windy		partly cloudy
thunder storm				breezy		partly cloudy				breezy		partly cloudy
thunder storm				windy		overcast				windy		overcast
thunder storm				breezy		overcast				breezy		overcast
mostly cloudy	medium					mostly cloudy	medium					mostly cloudy
mostly cloudy		medium				mostly cloudy		medium				mostly cloudy
mostly cloudy			normal			mostly cloudy			normal			mostly cloudy
mostly cloudy				calm		mostly cloudy				calm		mostly cloudy
mostly cloudy					none	mostly cloudy					none	mostly cloudy
moderate rain	medium	medium					cold	high				
light rain	cold	high					medium	medium				

Weather	temperature hist	humidity hist	pressure hist	wind hist	precipitation hist	cloud hist	temperature curr	humidity curr	pressure curr	wind curr	precipitation curr	cloud curr
heavy rain	medium				heavy		medium				heavy	
light rain	hot				light		hot				light	
moderate rain	hot				moderate		hot				moderate	
moderate rain	hot	high					hot	high				
heavy rain	hot				heavy		hot				heavy	
fog		high			light			high			light	
fog		high			moderate			high			moderate	
fog		high			heavy			high			heavy	
fog					light	overcast		high			light	overcast
fog					moderate	overcast		high			moderate	overcast
fog					heavy	overcast					heavy	overcast
thunder storm			high	windy					high	windy		
thunder storm			high	breezy					high	breezy		

clear	cold			windy			medium			calm		
partly cloudy	medium			calm		clear	cold			windy		partly cloudy

#### 4. Inference Engine:

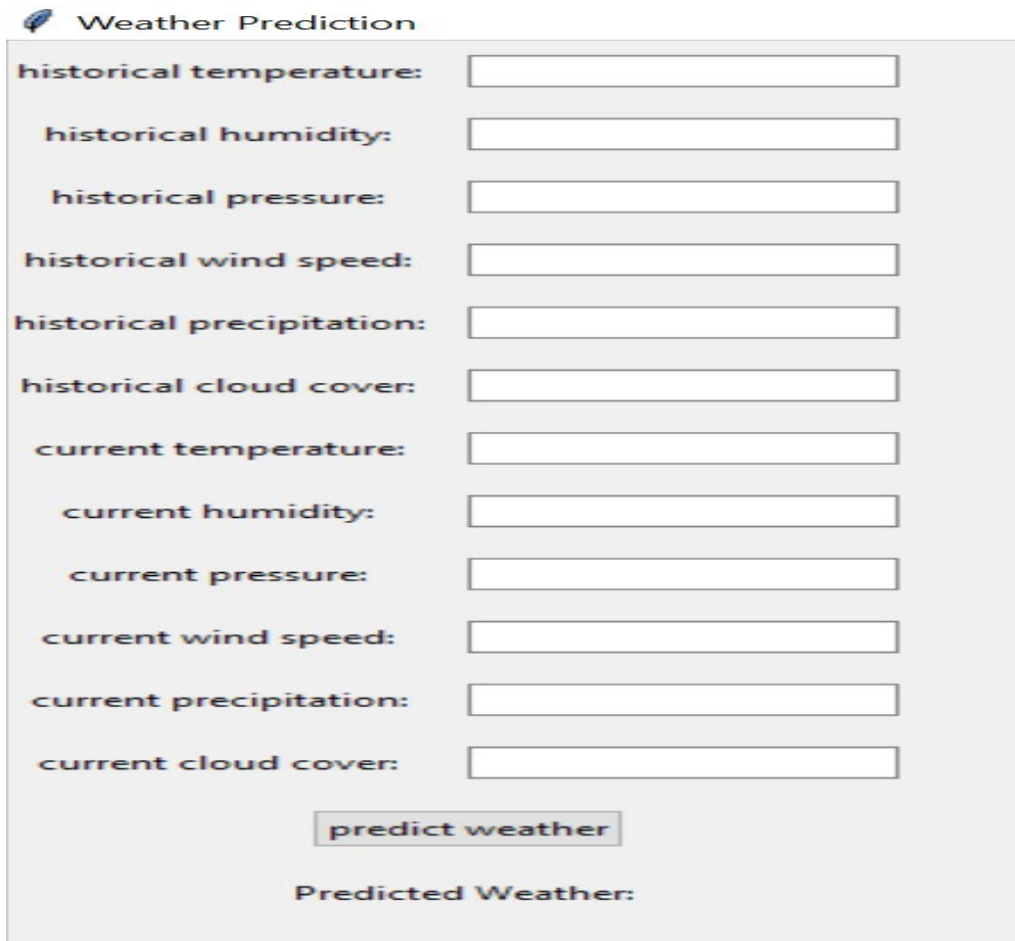
The inference engine is a crucial component of a rule-based system or a fuzzy logic system that processes the rules and performs the reasoning or inference process. It is responsible for evaluating the input conditions (antecedents) of the rules and activating the corresponding output actions (consequents).


#### 5. Defuzzification:

is the process of converting the result in fuzzy set form to a crisp result. It is important process for hardware application which process based on crisp data exchange. There is not theory to justify behavior of exchange other than commonsense reasoning such that the defuzzified output must represent a weight, voted, or must suitable solution. There are two main mechanism centroid method which based on finding a balance point of a property and maxima method which based in search for the highest pack and in our case we have used the Centroid method.

## 6. System Implementation and User Guide:

We have used **scikit-fuzzy** library in order to build our fuzzy logic model, and for building an application that the user can interact with, we have used **Tkinter** library in python for simple GUI.



 Weather Prediction

historical temperature:	<input type="text"/>
historical humidity:	<input type="text"/>
historical pressure:	<input type="text"/>
historical wind speed:	<input type="text"/>
historical precipitation:	<input type="text"/>
historical cloud cover:	<input type="text"/>
current temperature:	<input type="text"/>
current humidity:	<input type="text"/>
current pressure:	<input type="text"/>
current wind speed:	<input type="text"/>
current precipitation:	<input type="text"/>
current cloud cover:	<input type="text"/>

Predicted Weather:

historical temperature:	<input type="text" value="10"/>
historical humidity:	<input type="text" value="5"/>
historical pressure:	<input type="text" value="1000"/>
historical wind speed:	<input type="text" value="140"/>
historical precipitation:	<input type="text" value="300"/>
historical cloud cover:	<input type="text" value="50"/>
current temperature:	<input type="text" value="20"/>
current humidity:	<input type="text" value="7"/>
current pressure:	<input type="text" value="1010"/>
current wind speed:	<input type="text" value="130"/>
current precipitation:	<input type="text" value="259"/>
current cloud cover:	<input type="text" value="60"/>

Predicted Weather Condition is : moderate\_rain



## 7. Testing and Validation:

we have 2 weather datasets

the first dataset contains the input columns and second dataset contain output column then we merge two data based on temperature and pressure and output columns

then we map the output column to be like our output value

then we spilt the data to historical data and current data based on date column

then spilt the current data to X and Y

then we pass the hist and curr value to defuzzification and then get the final y pred

then we compare the y and y pred and the final accuracy is 22%

## 8. References:

Malik Shahzad Kaleem Awan, Mian Muhammad Awais, Predicting weather events using fuzzy rule based system, Applied Soft Computing 11 (2011) 56–63

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Riyaz P A, Gurusamy P, Sandeep Kartha, Surekha Mariam Varghese, Fuzzy Inference System for Weather Prediction

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