Fuzzy Logic-based Plant Water Adjustment (Fuzzy.py)

1. Overview

The Fuzzy.py script calculates an adjusted plant watering amount based on the current temperature using Fuzzy Logic. It fetches the current weather temperature, applies fuzzy logic rules, and computes the percentage change in water needed relative to a base quantity.

Key Features:

- Temperature fetching from wttr.in.
- Fuzzy Logic System (FLS) using scikit-fuzzy.
- Output: Adjusted water quantity in mL with dominant fuzzy categories.

Libraries Used:

- numpy → numerical operations, arrays.
- skfuzzy → fuzzy logic computations, membership functions.
- requests → HTTP requests to fetch weather.
- re → regex parsing for temperature extraction.

2. External Temperature Fetch

Workflow:

1. Sends a GET request to wttr.in.
2. Parses the returned string using regex to extract numeric temperature.
3. Returns temperature in °C or None if fetch fails.
3. Fuzzy Logic System (FLS) Definition

Inputs (Antecedent)
- Variable: temperature
- Range: -10°C to 40°C

Step 1: Defining Membership Functions (Fuzzification)

A. Input Variable: Current Temperature (T)

Let's define the sets and their associated parameters (where the degree of membership μ=1):

Set (Linguistic)	Parameters (a, b, c for trimf)
Freezing	(-10, -10, 0, 5)
Very Cold	(5, **10**, 15)
Cold	(10, **15**, 20)
Moderate	(20, **25**, 30)
Hot	(25, **30**, 35)
Very Hot	(30, **35**, 40)

Triangular Membership Function formula:
$\mu(x;a,b,c) = 0$ if $x \le a$ or $x \ge c$
$= (x-a)/(b-a)$ if $a < x < b$

= (c-x)/(c-b) if b≤x<c
Trapezoidal Membership Function formula:μ(x;a,b,c,d) = 0 if x≤a or x≥d
= (x-a)/(b-a) if a<x<b
= 1 if b≤x≤c
= (d-x)/(d-c) if c<x<d

Step 2: Output (Consequent)

- **Variable: `percent_change` (in %)**
- **Range: `-30%` to `20%`**
- **Categories:**

Category	Range/Function	Effect
Extreme_Decrease	**[-31, -30, -28]**	**Drastically reduce water**
Large_Decrease	**[-25, -15, -10]**	**Significantly reduce water**
Decrease	**[-15, -8, 0]**	**Slightly reduce water**
No_Change	**[-5, 0, 5]**	**Keep water same**
Increase	**[0, 8, 15]**	**Slightly increase water**
Large_Increase	**[10, 15, 20]**	**Significantly increase water**

Step 3: Fuzzy Rules

Rules define the relationship between temperature and water adjustment:

Rule	Condition	Output
0	**Freezing**	**Extreme_Decrease**
1	**Very_Cold**	**Large_Decrease**
2	**Cold**	**Decrease**
3	**Moderate**	**No_Change**
4	**Hot**	**Increase**
5	**Very_Hot**	**Large_Increase**

Step 4: Defuzzification

Formula (Centroid Method):

$$y = \int \mu_{output}(x) * x \, dx \, / \int \mu_{output}(x) \, dx$$

To get crisp value

Step 5. Adjusted Water Calculation(Crisp Value)

Calculate final water quantity:

adjusted_mL = base_quantity_ml * percent_change / 100
final_quantity = base_quantity_ml + adjusted_mL

5. Determine dominant fuzzy categories for input and output

6. Return all values