FUZZY SMART HOME MANAGEMENT SYSTEM FOR GARDENING

- Fuzzy Sets and Systems (Evaluation Report)

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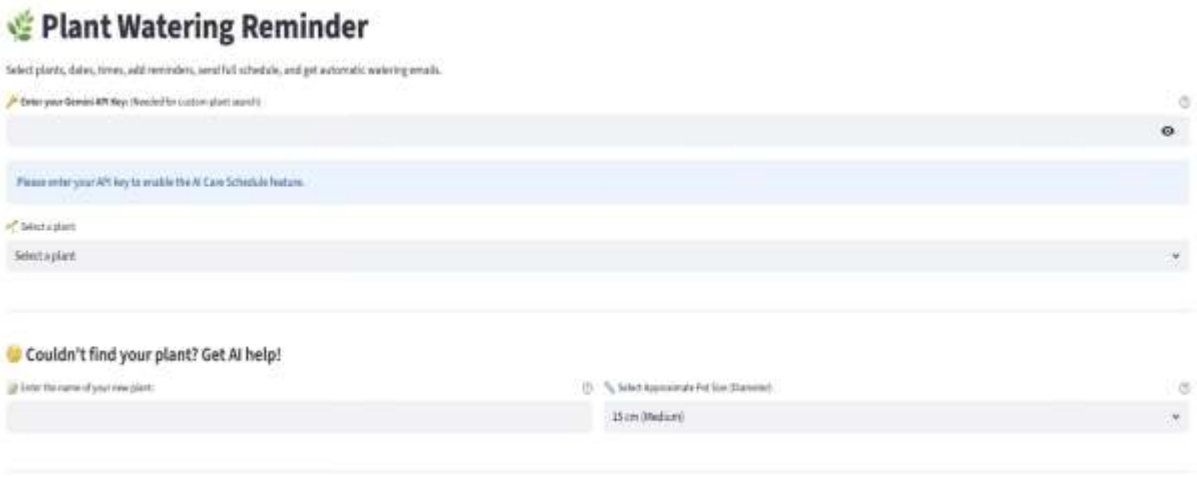
Evaluation Goal and Setup

The primary goal of this evaluation is to assess whether the plant watering adjustment model—which uses a fuzzy rule-based inference system —behaves **plausibly and consistently** across different environmental and scheduling conditions.

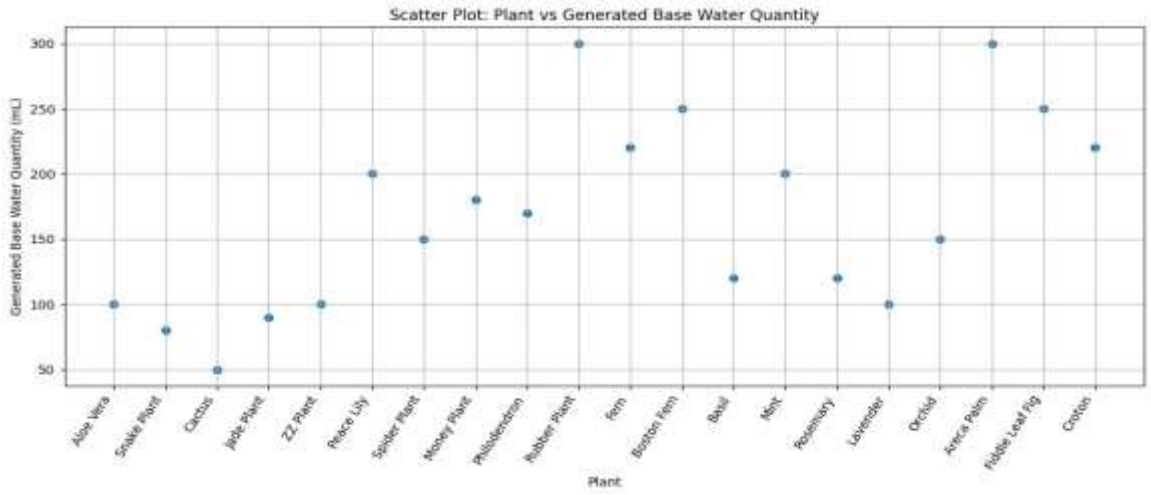
For this evaluation, the dataset is generated using LLM:

- A fixed base watering value (ml_per_watering) per plant
- Pot size of the respective plant
- multiple records per plant, combining:
  - Temperatures: -10 to 30 °C with different intervals
  - Weekly frequencies: 0, 1, 2, 3, 4 times/week
- An adjusted_ml value computed from our adjustment fuzzy logic

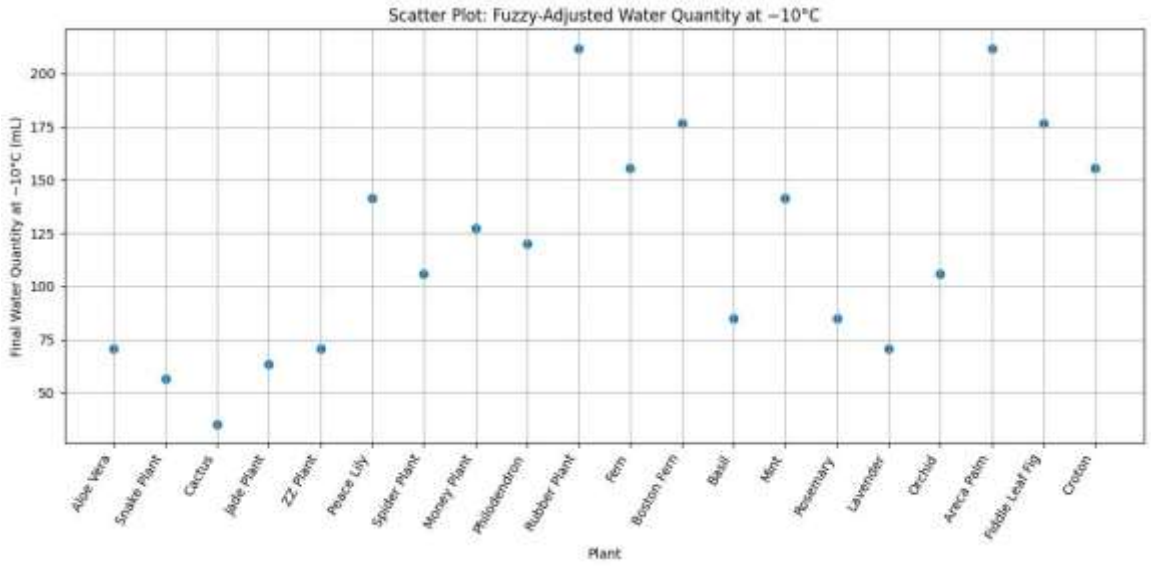


Evaluation Based on Statistical Analysis

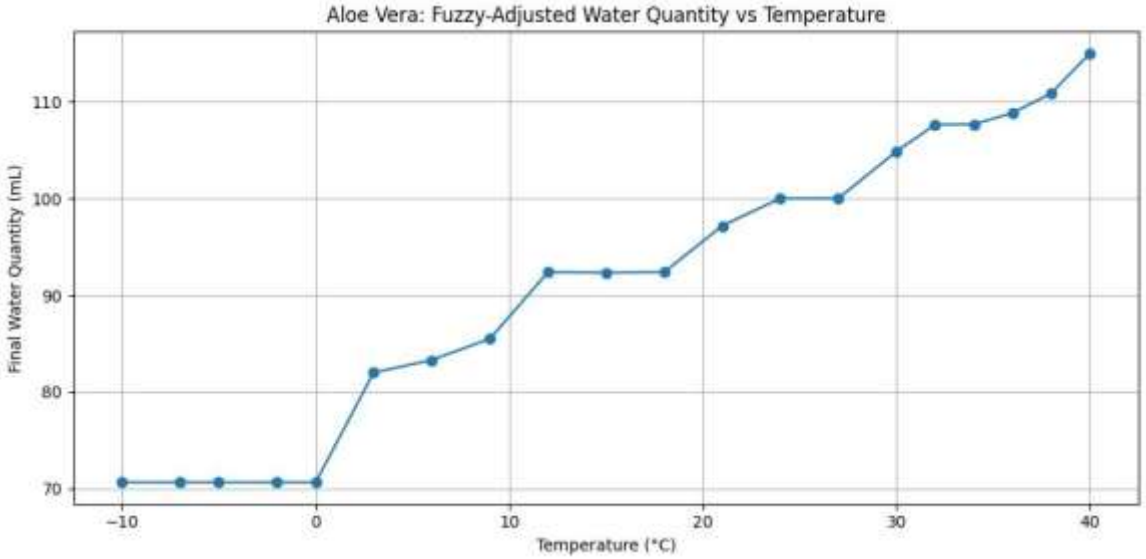
1. Generated Base Water Quantity: Shows the initial, widely varying AI-recommended water amounts (mL) for different plants (e.g., Aloe Vera is 100 mL, Fern is 300 mL).



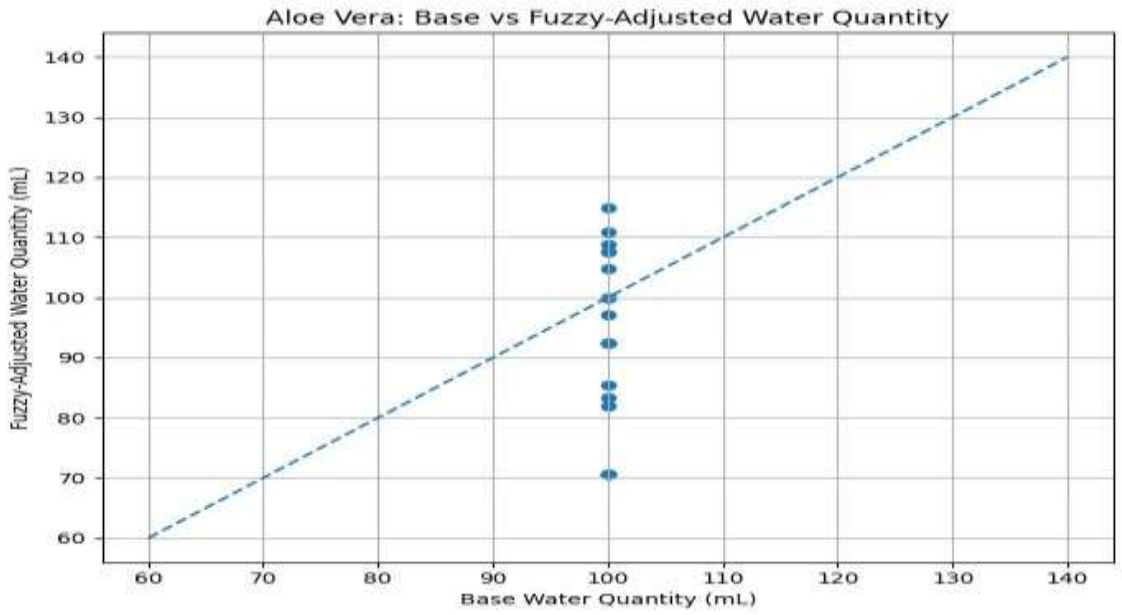
2.Fuzzy-Adjusted Water Quantity at -10 degrees: Shows the final water quantity for all plants when environmental temperature is extremely low (-10 degrees), resulting in a general reduction from the base quantity.



3.Aloe Vera: Fuzzy-Adjusted Water Quantity vs Temperature: Demonstrates that Aloe Vera's water need is **low and constant** below 0 degrees (around70mL) and **increases steadily** with rising temperatures, reflecting greater water loss in warmer conditions.



4.Aloe Vera: Base vs Fuzzy-Adjusted Water Quantity: Confirms the **Base Quantity** is fixed at 100 mL, while the **Fuzzy-Adjusted Quantity** for Aloe Vera fluctuates between about 70 mL and over 110 mL depending on the temperature-based adjustment.



The graphs confirm that the fuzzy rule-based adjustment logic is working correctly and plausibly:

- Adjusts Base Quantity: The system successfully modifies the AI-generated Base Water Quantity (e.g.,100 mL for Aloe Vera).
- Correct Temperature Response: The Final Water Quantity increases steadily as temperature rises, confirming the rule that warmer environments require more water to offset higher evaporation. At low temperatures (e.g., -10^C), it consistently reduces the required water volume.
- Internal Consistency: The logic maintains consistency by balancing the required water dose against the temperature.

Evaluation Based on users and surveys

Participant group:

- 10 users participated
- Basic plant care experience
- Iterative feedback and suggestions
- Consistent involvement across iterations

Evaluation Design:
The evaluation followed a formative, iterative user-centered design approach, focusing on usability, recommendation quality, and system interpretability.

Each iteration consisted of:

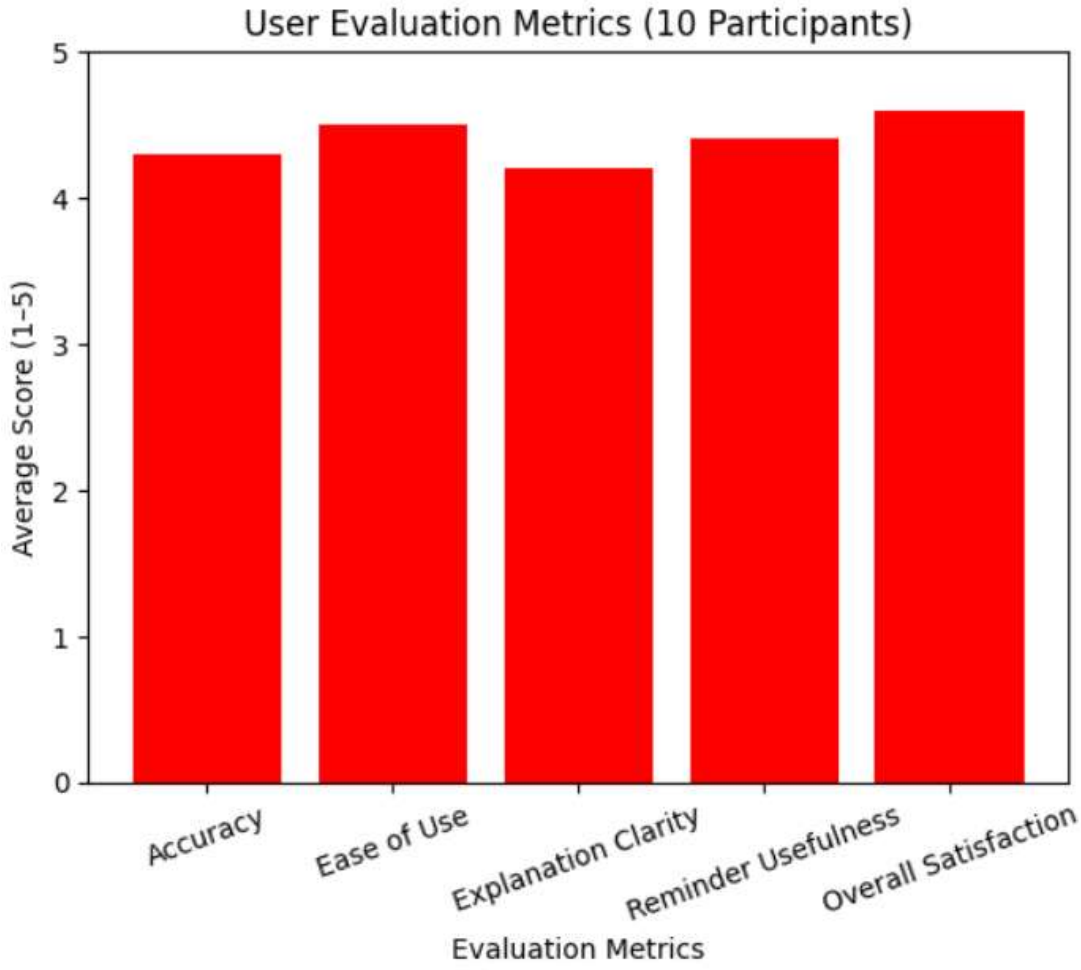
1. Prototype interaction – users input plant type, pot size, and reminder preferences.
2. System output observation – users reviewed recommended water quantity and reminders.
3. Feedback collection – users provided structured and open-ended feedback.
4. Prototype refinement – changes were implemented based on aggregated feedback.

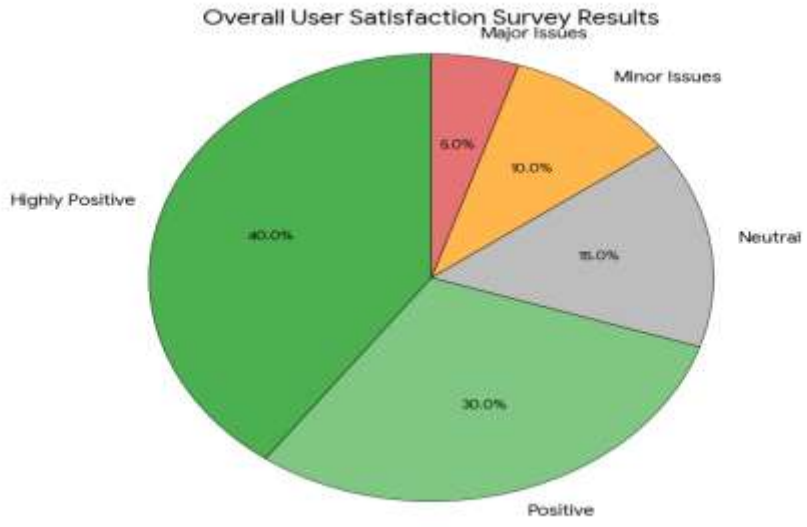
This cycle was repeated until no major usability issues were reported.

Evaluation Metrics:
User feedback was evaluated using both quantitative and qualitative measures:

Quantitative Metrics (Likert Scale: 1–5)

- Perceived accuracy of watering recommendations
- Ease of use of the interface
- Clarity of explanations for recommended water quantities
- Usefulness of reminder scheduling and overall satisfaction


User Evaluation Metrics (10 Participants)
Average Score (1–5)
0
1
2
3
4
5
Accuracy
Ease of Use
Explanation Clarity
Reminder Usefulness
Overall Satisfaction
Evaluation Metrics


Overall User Satisfaction Survey Results
Major Issues
Minor Issues
Neutral
Positive
Highly Positive
6.0%
10.0%
15.0%
30.0%
40.0%

Category	Percentage	Example Feedback
Highly Positive	40%	"The Gemini AI generated a perfect care schedule for my rare plant, and the fuzzy logic adjustment is brilliant—it prevented me from overwatering during a cold snap!"
Positive	30%	"The automatic email reminders are reliable, and the ability to schedule watering for seven days in advance is very convenient. The interface is clean and easy to use."
Neutral	15%	"The scheduling feature works well, but it took a bit longer than expected (2-3 minutes) to receive the 'Full Schedule' email after sending. Good product overall."
Minor Issues	10%	"The time selector for scheduling could be improved; I had a slight difficulty setting the exact minute for the reminder. The content of the reminder email was perfect, though."
Major Issues	5%	"I entered a new plant name but couldn't get the 'Get AI Care Schedule' button to respond, despite entering my Gemini API Key. I had to choose an existing plant instead."

Qualitative Metrics

- User suggestions for rule adjustments (e.g., pot size influence)
- Comments on trust and understandability of fuzzy explanations
- Observations on interaction flow and input clarity.

Evaluation Summary

Fuzzy Modelling:

A fuzzy inference system with membership functions was used. Inputs like plant water requirement and pot size were fuzzified, and a compact rule base encoded intuitive plant care knowledge. Centroid defuzzification produced precise yet flexible watering recommendations.

Interactive Evaluation:

The system supports dynamic input and reminder-based recommendations. Fixed inputs produce consistent outputs, confirming robustness. Reminder emails include fuzzy-based explanations for transparency.

Overall Assessment:

The prototype delivers stable, interpretable, and context-aware recommendations, effectively modelling uncertainty and supporting flexible plant care decisions, meeting both academic and practical objectives.

Note: **The Plant Watering Reminder application is built utilizing the Gemini Flash 2.5 Pro LLM for intelligent care schedule generation and a Fuzzy Logic engine for adaptive, environment-adjusted watering recommendations, all delivered through a streamlined Streamlit frontend.**