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HARSHIT SHARMA D20B/51
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AIM: To implement fuzzy set properties.

THEORY: Fuzzy set theory is an extension of classical (or crisp) set theory. In classical set theory, an element either belongs to a set (membership value = 1) or does not belong (membership value = 0). There is no in-between. However, in many real-life situations, such a binary distinction is too rigid.

Fuzzy set theory was introduced by Lotfi Zadeh in 1965 to deal with such uncertainty and imprecision. It allows elements to have partial membership in a set. This partial membership is expressed by a membership function, which assigns a value between 0 and 1 to each element.

A fuzzy set is defined as a set where each element has a degree of membership, instead of just being in or out of the set. These values can represent how strongly an element belongs to the set.

Fuzzy Set Operations: Union of Fuzzy Sets:

The union of two fuzzy sets A and B is denoted as A ∪ B. The membership function is defined as:

μA∪B(x) = max(μA(x), μB(x))

This means the degree of membership of an element in the union set is the maximum of its membership in set A and set B.

Intersection of Fuzzy Sets:

The intersection of two fuzzy sets A and B is denoted as A ∩ B. The membership function is defined as:

μA∩B(x) = min(μA(x), μB(x))

This means the degree of membership of an element in the intersection set is the minimum of its membership in set A and set B.

Complement of a Fuzzy Set:

The complement of a fuzzy set A is denoted as A'. The membership function is defined as:

μA'(x) = 1 − μA(x)

This operation calculates how much an element does not belong to the set A. It is simply 1 minus the membership value in A.

Scalar Multiplication of a Fuzzy Set:

If α is a scalar between 0 and 1, the scalar multiplication of fuzzy set A is defined as:

μαA(x) = α · μA(x)

This operation scales the degree of membership. For example, if α = 0.5, all membership values will be reduced by half.

Fuzzy Sum of Two Sets:

The fuzzy sum (also called algebraic sum) of two sets A and B is denoted as A ⊕ B. The membership function is defined as:

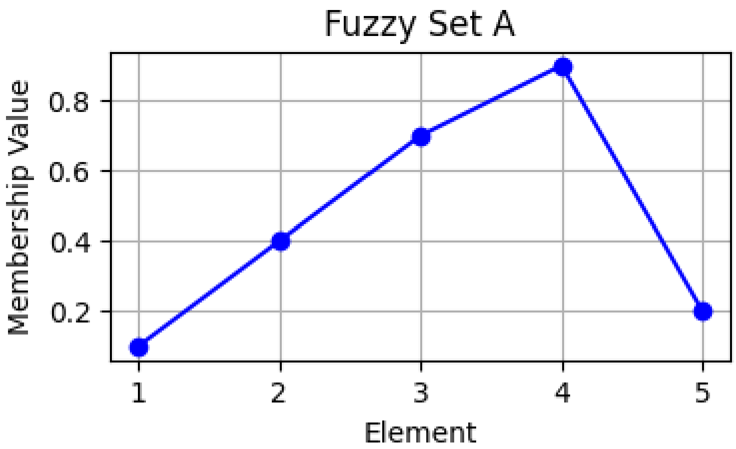
μA+B(x) = μA(x) + μB(x) − μA(x) · μB(x)

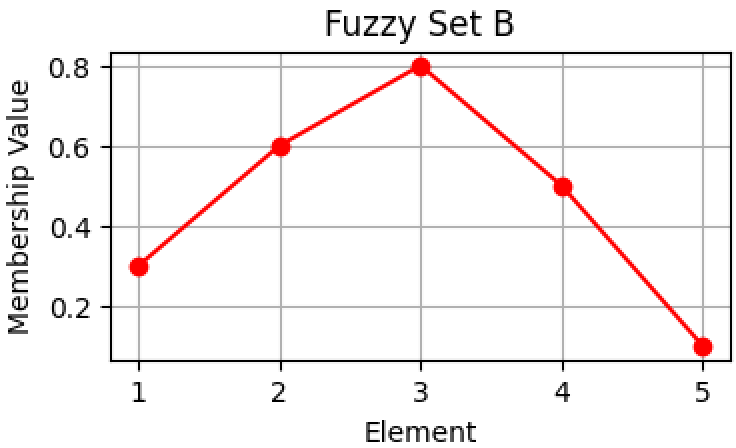
This operation combines the memberships in such a way that it gives a total membership but still keeps the result in the [0, 1] range.

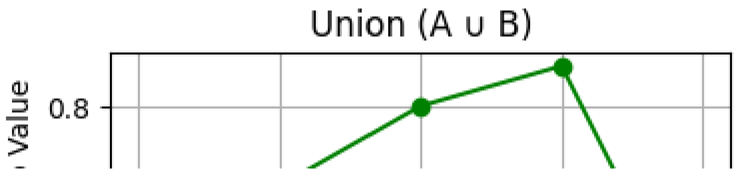
Conclusion: Fuzzy sets and their operations provide a flexible way to handle real-world problems that involve uncertainty and partial truth. By implementing these properties using Python, we can visualize and understand how fuzzy logic works practically.

```
import matplotlib.pyplot as plt



x = [1, 2, 3, 4, 5]

A = [0.1, 0.4, 0.7, 0.9, 0.2]  # Fuzzy Set A
B = [0.3, 0.6, 0.8, 0.5, 0.1]  # Fuzzy Set B



A_union_B = [max(a, b) for a, b in zip(A, B)]



A_intersection_B = [min(a, b) for a, b in zip(A, B)]



A_complement = [1 - a for a in A]



A_sum_B = [a + b - a * b for a, b in zip(A, B)]



plots = [
    ("Fuzzy Set A", A, 'blue'),
    ("Fuzzy Set B", B, 'red'),
    ("Union (A ∪ B)", A_union_B, 'green'),
    ("Intersection (A ∩ B)", A_intersection_B, 'purple'),
    ("Complement of A (A')", A_complement, 'orange'),
    ("Fuzzy Sum (A ⊕ B)", A_sum_B, 'cyan')
]

for title, y_values, color in plots:
```

```
        plt.figure(figsize=(4, 2))
        plt.plot(x, y_values, 'o-', color=color)
        plt.title(title)
        plt.xlabel('Element')
        plt.ylabel('Membership Value')
        plt.grid(True)
        plt.show()
```

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