AIDS II EXP 7

Name: Deepa Behrani

Roll no: 05

Class: D20B

AIM:

To implement and visualize various properties of fuzzy sets, including Union, Intersection, Complement, Algebraic Product, Bounded Sum, and Bounded Difference.

THEORY:

Fuzzy set theory is an extension of classical set theory, where the membership of an element in a set is not restricted to binary values (0 or 1). Instead, it is represented as a value between 0 and 1, indicating the degree of membership.

In classical sets, an element either belongs to a set or does not. Fuzzy sets, on the other hand, allow partial membership, which is useful in modeling situations where things are not clearly defined or have varying degrees of truth.

The following properties of fuzzy sets will be explored in this experiment:

1. **Union of Fuzzy Sets:**
   The union of two fuzzy sets represents the membership of an element in at least one of the sets. The membership value in the union is determined by taking the maximum of the membership values from the two sets.

$$\mu_{A\cup B}(x) = \max(\mu_A(x), \mu_B(x))$$

2. **Intersection of Fuzzy Sets:**
   The intersection of two fuzzy sets represents the degree to which an element belongs to both sets. The membership value in the intersection is determined by the minimum of the membership values from the two sets.

$$\mu_{A\cap B}(x) = \min(\mu_A(x), \mu_B(x))$$

3. **Complement of a Fuzzy Set:**
   The complement of a fuzzy set indicates how much an element does **not** belong to the set. The complement is calculated by subtracting the membership value from 1.

$$\mu_{A'}(x) = 1 - \mu_A(x)$$

4. **Algebraic Sum of Fuzzy Sets:**
   The algebraic sum represents a modified union of two fuzzy sets, taking into account both their membership values and their overlap. It is calculated as:

$$\mu_{A+B}(x) = \mu_A(x) + \mu_B(x) - \mu_A(x) \cdot \mu_B(x)$$

5. **Algebraic Product of Fuzzy Sets:**
   The algebraic product represents the intersection of two fuzzy sets. This is computed by multiplying the membership values of the two sets. It models the situation where the two sets are strongly related.

$$\mu_{A \cdot B}(x) = \mu_A(x) \cdot \mu_B(x)$$

6. **Bounded Sum of Fuzzy Sets:**
   The bounded sum represents the union of two fuzzy sets, but with the membership value capped at 1. This ensures that the degree of membership in the result does not exceed

$$\mu_{A+B}(x) = \min(1, \mu_A(x) + \mu_B(x))$$

7. **Bounded Difference of Fuzzy Sets:**
   The bounded difference represents how much the membership of an element in set A exceeds its membership in set B. It is computed by subtracting the membership value of B from A, ensuring the result is never less than 0.

$$\mu_{A-B}(x) = \max(0, \mu_A(x) - \mu_B(x))$$

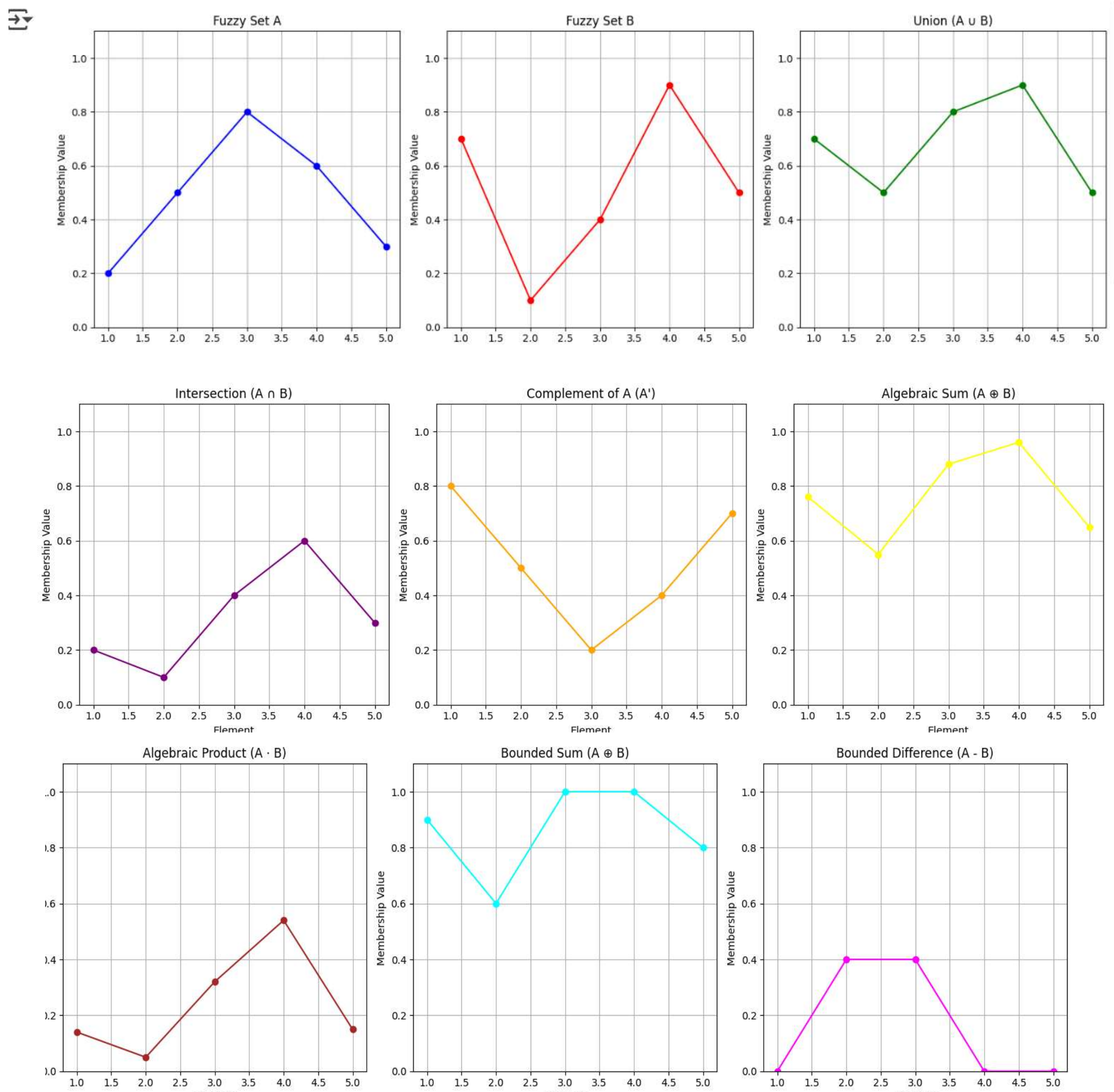
CODE:

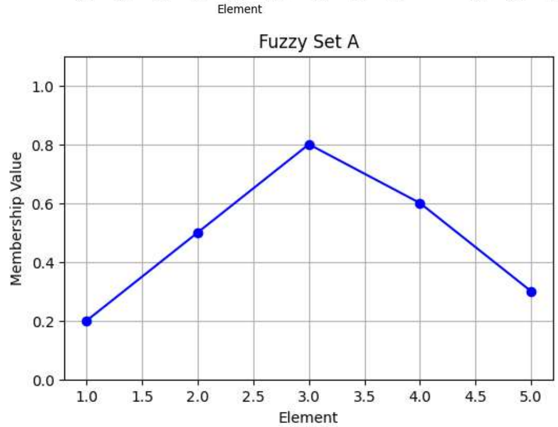
```
# Fuzzy Set Properties Implementation in Python
# Run this directly in Google Colab

import matplotlib.pyplot as plt

# ------------------------------
# Step 1: Define Fuzzy Sets
# ------------------------------
x = [1, 2, 3, 4, 5]  # Elements
```

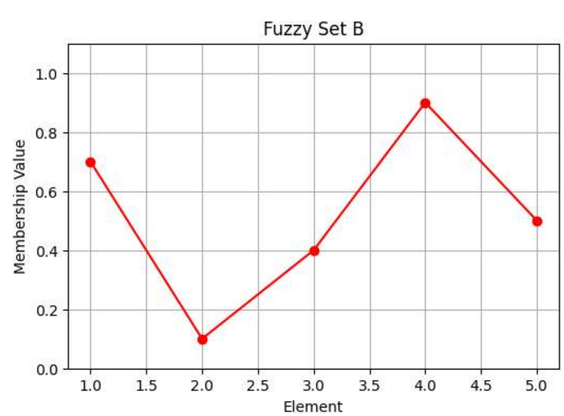
```
A = [0.2, 0.5, 0.8, 0.6, 0.3]  # Membership values of set A
B = [0.7, 0.1, 0.4, 0.9, 0.5]  # Membership values of set B

# ------------------------------
# Step 2: Perform Fuzzy Operations
# ------------------------------
A_union_B = [max(a, b) for a, b in zip(A, B)]                    # Union
A_intersection_B = [min(a, b) for a, b in zip(A, B)]              # Intersection
A_complement = [1 - a for a in A]                                 # Complement of A
A_algebraic_sum_B = [a + b - a * b for a, b in zip(A, B)]         # Algebraic Sum
A_product_B = [a * b for a, b in zip(A, B)]                       # Algebraic Product
A_plus_B = [min(1, a + b) for a, b in zip(A, B)]                  # Bounded Sum
A_minus_B = [max(0, a - b) for a, b in zip(A, B)]                 # Bounded Difference

# ------------------------------
# Step 3: Store plots in a list
# ------------------------------
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'),
    ("Algebraic Sum (A ⊕ B)", A_algebraic_sum_B, 'yellow'),
    ("Algebraic Product (A · B)", A_product_B, 'brown'),
    ("Bounded Sum (A ⊕ B)", A_plus_B, 'cyan'),
    ("Bounded Difference (A - B)", A_minus_B, 'magenta')
]

# ------------------------------
# Step 4: Show all plots in one figure (subplots)
# ------------------------------
plt.figure(figsize=(15, 15))

for i, (title, y_values, color) in enumerate(plots, 1):
    plt.subplot(3, 3, i)
    plt.plot(x, y_values, 'o-', color=color)
    plt.title(title)
    plt.xlabel('Element')
    plt.ylabel('Membership Value')
    plt.ylim(0, 1.1)
    plt.grid(True)

plt.tight_layout()
plt.show()

# ------------------------------
# Step 5: (Optional) Show each plot separately
# ------------------------------
for title, y_values, color in plots:
    plt.figure(figsize=(6, 4))
    plt.plot(x, y_values, 'o-', color=color)
    plt.title(title)
    plt.xlabel('Element')
    plt.ylabel('Membership Value')
    plt.ylim(0, 1.1)
```

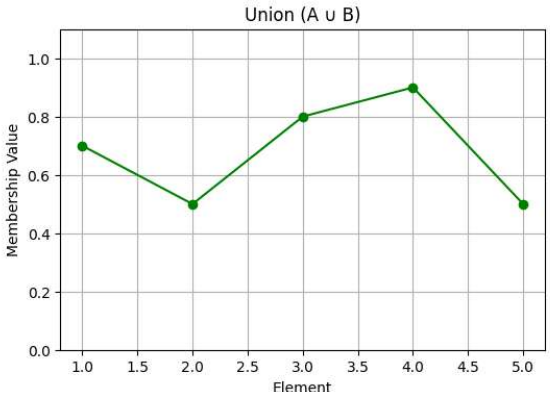
```
plt.grid(True)
plt.show()
```

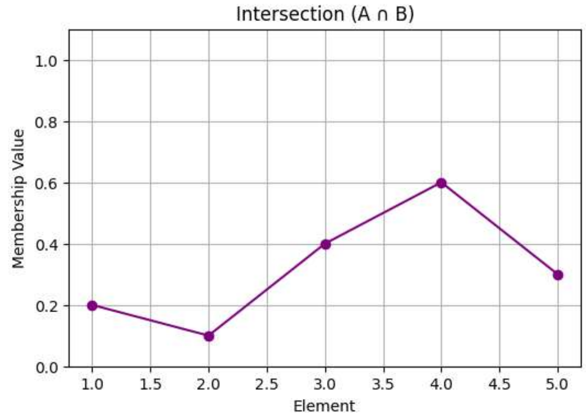
OUTPUT:

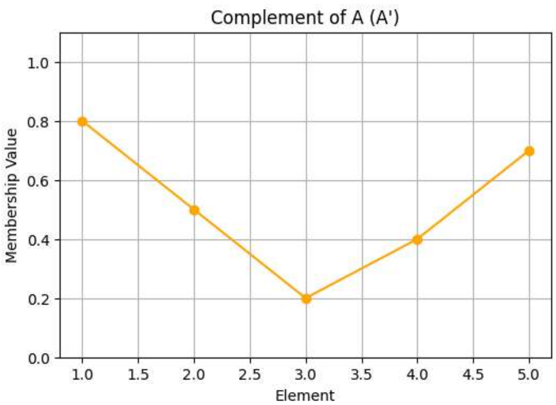


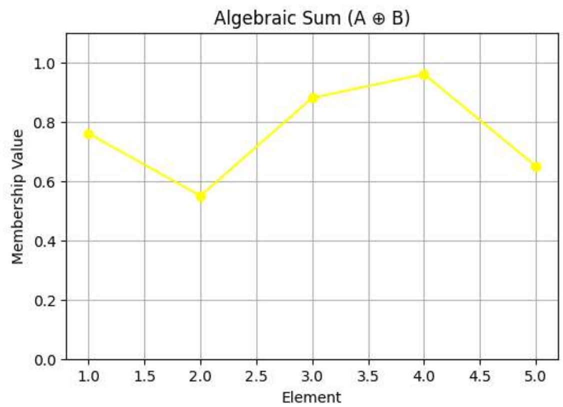


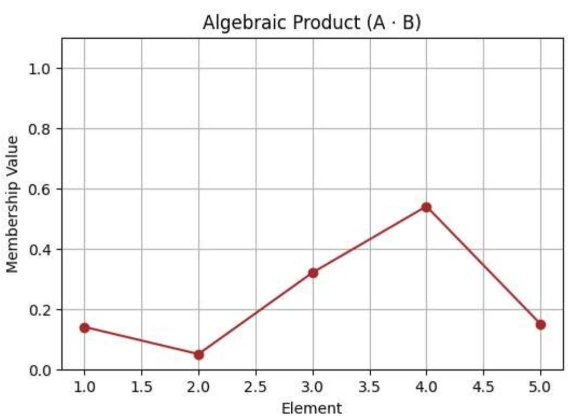


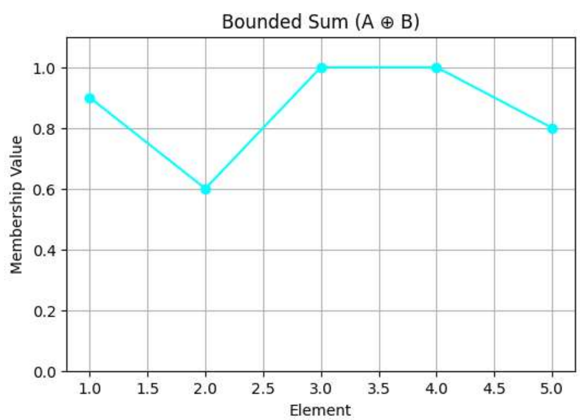


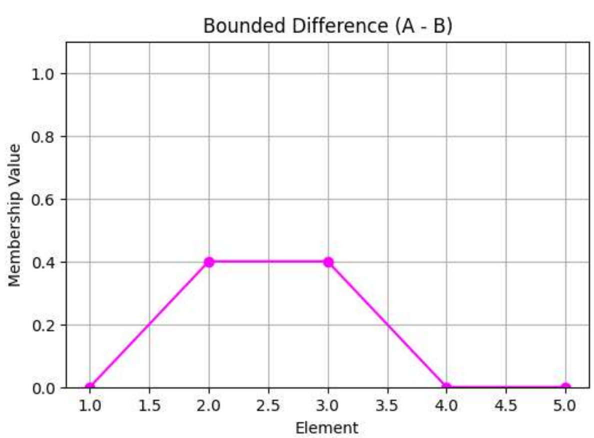












CONCLUSION : Fuzzy set theory extends classical set theory by allowing partial membership, making it effective for modeling uncertainty and imprecision. The Algebraic Sum operation helps visualize how sets overlap and combine, reflecting both shared and individual contributions. This makes fuzzy sets useful in decision-making and control systems, where real-world data often involves ambiguity and partial truth