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D20B
Roll No: 09

DS LAB EXP : 07

AIM: To implement fuzzy set Properties

THEORY:
Fuzzy set theory extends classical set theory to handle the concept of partial membership. In classical set theory, an element either belongs to a set or it does not, which is a binary (0 or 1) membership function. In fuzzy set theory, membership is expressed in degrees ranging between 0 and 1.

1. **Union of Fuzzy Sets:**
$\mu_{A \cup B}(x)=\max(\mu_A(x),\mu_B(x))$
- Membership in the union is the highest membership value of an element in either set, reflecting that the element belongs to at least one of the sets.

2. **Intersection of Fuzzy Sets:**
$\mu_{A \cap B}(x)=\min(\mu_A(x),\mu_B(x))$
- Membership in the intersection is the lowest membership value of the element in both sets, indicating that the element belongs to both sets to the least extent.

3. **Complement of a Fuzzy Set:**
$\mu_{A'}(x)=1-\mu_A(x)$
- Membership in the complement is the inverse of the membership in the original set, showing how much an element does not belong to the set.

4. **Scalar Multiplication of a Fuzzy Set**:
$\mu_{\alpha A}(x)=\alpha \cdot \mu_A(x)$
- Membership values are scaled by a factor, adjusting the degree of membership accordingly, where between 0 and 1 reduces membership.

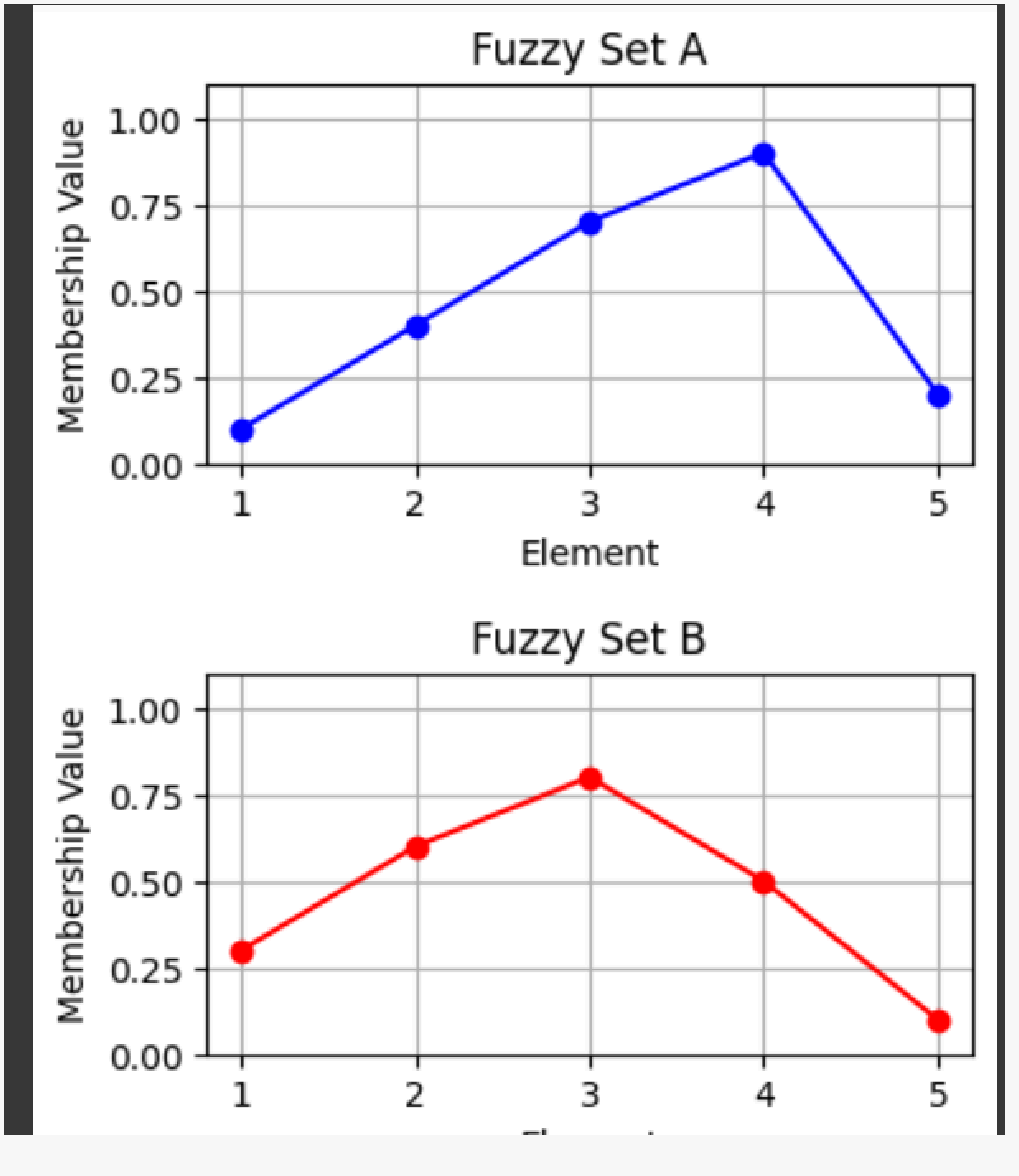
5. **Sum of Fuzzy Sets:**
$\mu_{A+B}(x)=\min(1,\mu_A(x)+\mu_B(x))$
- Membership values are combined by summing the memberships of an element in both sets, with the result capped at 1 to ensure values remain within the valid range.

CODE:

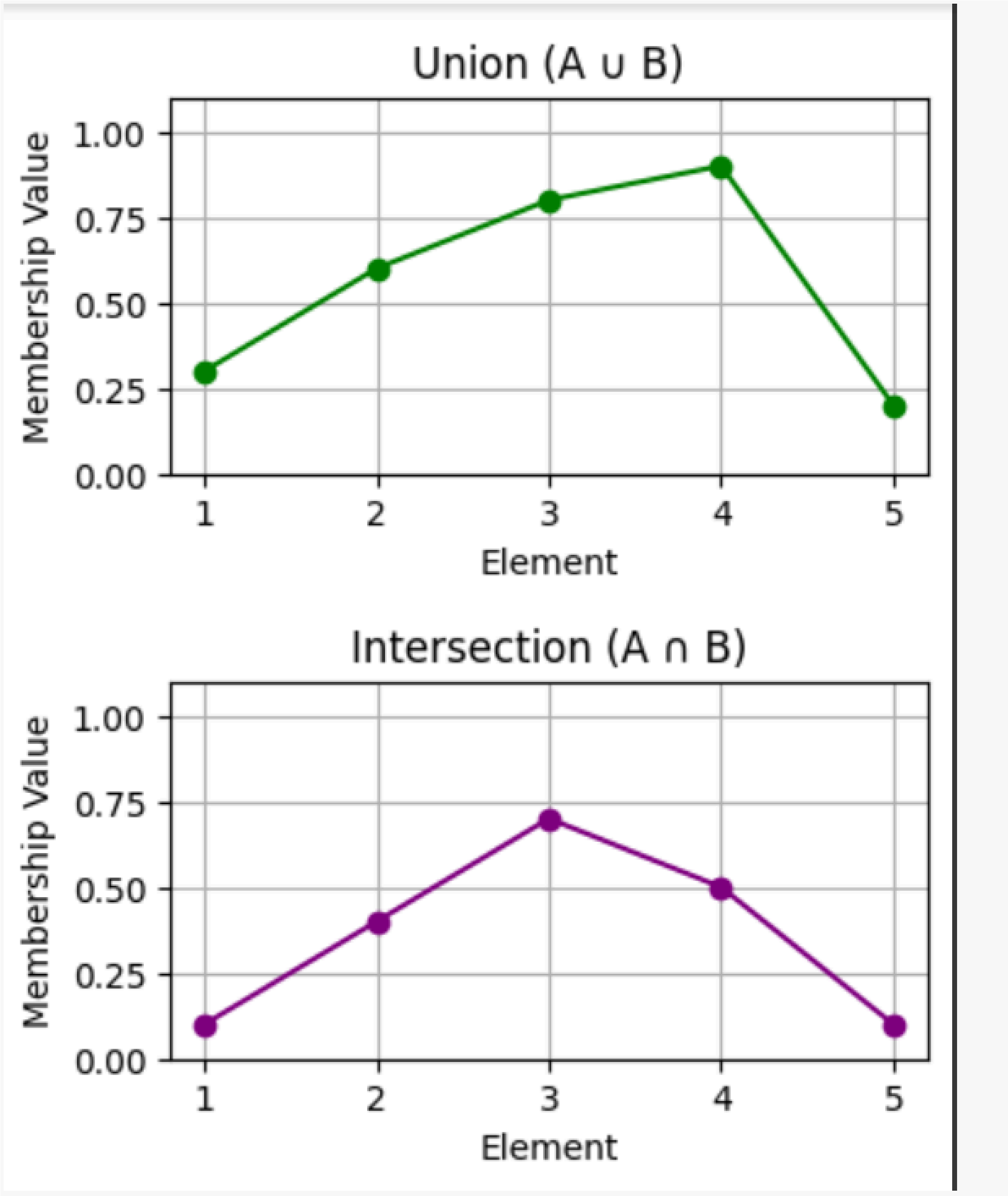
```python
import matplotlib.pyplot as plt

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

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

# Union and Intersection
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)]

# Complement of A
A_complement = [1 - a for a in A]

# Scalar Multiplication (α * A) with α = 0.5
alpha = 0.5
A_scalar = [alpha * a for a in A]

# Fuzzy Sum (A + B) -> min(1, A+B)
A_sum_B = [min(1, a + b) for a, b in zip(A, B)]

# List of plots to generate
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'),
    (f"Scalar Multiplication (αA) with α={alpha}", A_scalar, 'brown'),
    ("Fuzzy Sum (A + B)", A_sum_B, 'cyan')
]
```

```
]

# Generate each plot
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.ylim(0, 1.1)   # keep values between 0 and 1
    plt.grid(True)
    plt.show()
```

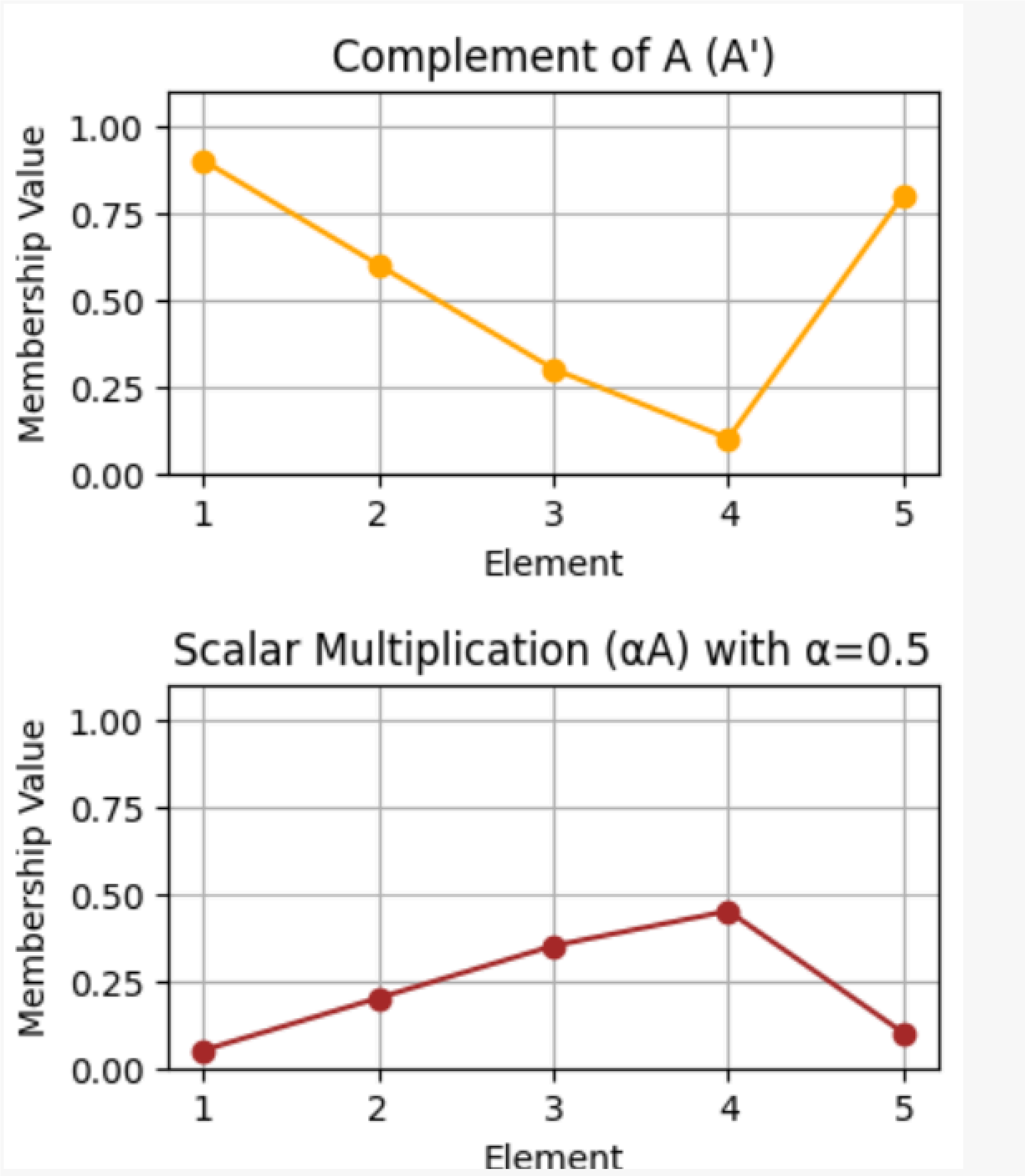
OUTPUT-

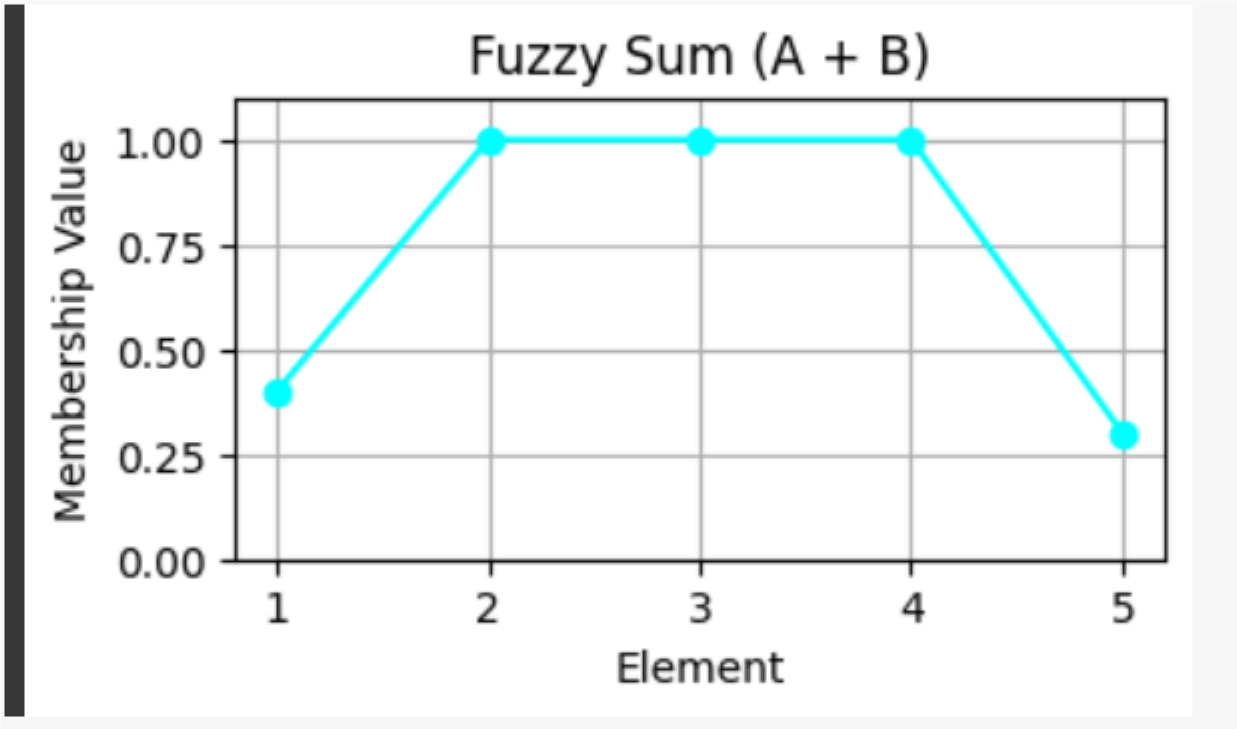


Fuzzy Set A
Membership Value
1.00
0.75
0.50
0.25
0.00
1
2
3
4
5
Element
Fuzzy Set B
Membership Value
1.00
0.75
0.50
0.25
0.00
1
2
3
4
5



Union (A ∪ B)
Membership Value
1.00
0.75
0.50
0.25
0.00
1
2
3
4
5
Element
Intersection (A ∩ B)
Membership Value
1.00
0.75
0.50
0.25
0.00
1
2
3
4
5
Element


Complement of A (A')
Membership Value
1.00
0.75
0.50
0.25
0.00
1
2
3
4
5
Element
Scalar Multiplication (αA) with α=0.5
Membership Value
1.00
0.75
0.50
0.25
0.00
1
2
3
4
5
Element



CONCLUSION: Thus , we have implemented the properties of fuzzy sets.

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