question1

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1 Question 1

Let A(x) and B(x) be two fuzzy sets of speed limit on a highway, defined by the following membership functions:

1.1 a. Fuzzy set A: "Low speed limit"

```
A(x) = { 1,                 if x < 30 (low speed)
         (x-30)/(50-30),    if 30 < x < 50 (moderately low speed)
         (x-50)/(70-50),    if 50 < x < 70 (increasing speed)
         0,                 if x > 70 (not low speed)
       }
```

1.2 b. Fuzzy set B: "High speed limit"

```
B(x) = { 0,                 if x < 60 (Not high speed)
         (x-60)/(80-60),    if 60 < x < 80 (moderately high speed)
         (x-80)/(100-80),   if 80 < x < 100 (increasing speed)
         1,                 if x > 100 (high speed)
       }
```

Now, perform the following operations to obtain the resultant set and plot the same:

i. Union - (A B)x = max(A(x), B(x))

ii. Intersection - (A B)x = min(A(x), B(x))

iii. Complement of both sets - A^(-1)(x) = 1 - A(x), B^(-1)(x) = 1 - B(x)

iv. Difference of the two sets – (A - B)x = (A(x) - B(x))

[1]:
```
import numpy as np
import matplotlib.pyplot as plt

# Define membership functions
def mu_A(x):
```

```
    if x < 30:
        return 1
    elif 30 <= x < 50:
        return (x - 30) / 20
    elif 50 <= x < 70:
        return (x - 50) / 20
    else:
        return 0

def mu_B(x):
    if x < 60:
        return 0
    elif 60 <= x < 80:
        return (x - 60) / 20
    elif 80 <= x < 100:
        return (x - 80) / 20
    else:
        return 1

# Generate x values
x = np.linspace(0, 120, 1000)

# Calculate membership values
y_A = [mu_A(i) for i in x]
y_B = [mu_B(i) for i in x]

# i. Union
y_union = np.maximum(y_A, y_B)

# ii. Intersection
y_intersection = np.minimum(y_A, y_B)

# iii. Complement
y_complement_A = 1 - np.array(y_A)
y_complement_B = 1 - np.array(y_B)

# iv. Difference
y_difference = np.maximum(0, np.array(y_A) - np.array(y_B))

# Plotting
plt.figure(figsize=(15, 10))

plt.subplot(3, 2, 1)
plt.plot(x, y_A, label='A(x): Low speed limit')
plt.plot(x, y_B, label='B(x): High speed limit')
plt.title('Original Fuzzy Sets')
plt.legend()
```

```
plt.subplot(3, 2, 2)
plt.plot(x, y_union)
plt.title('i. Union')

plt.subplot(3, 2, 3)
plt.plot(x, y_intersection)
plt.title('ii. Intersection')

plt.subplot(3, 2, 4)
plt.plot(x, y_complement_A, label="A'(x)")
plt.plot(x, y_complement_B, label="B'(x)")
plt.title("iii. Complement")
plt.legend()

plt.subplot(3, 2, 5)
plt.plot(x, y_difference)
plt.title('iv. Difference A(x) - B(x)')

plt.tight_layout()
plt.show()
```