5358 HW Fuzzy

1. The speed limit is 60 mph on an open highway with no traffic. Here are three obvious rules to control your car with a fuzzy control system.

   (a) If you are going too fast, then slow down.

   (b) If you are going close to the speed limit, stay at roughly the same speed.

   (c) If you are going too slow, then speed up.

   We interpret "slow down" and "speed up" as negative acceleration (deceleration) and positive acceleration.[1] Let's measure acceleration in

   (miles per hour) per second.

   (a) Draw and label fuzzy membership functions for the antecedents and consequents of these fuzzy control rules. Label your graphs clearly with the corresponding fuzzy linguistic variables, velocities and acceleration numbers. (Like any fuzzy control system, there is not a unique answer here. I'm looking for a reasonable answer that, on one hand, doesn't take forever and, on the other, doesn't jerk you around in the passenger seat.)

   (b) Evaluate the instantaneous response (*i.e.* acceleration) of your system when

      i. you are going the speed limit, and

      ii. you're going 50 mph.

   (c) Repeat the problem using clipped membership functions in the defuzzification step.

2. Let A and B be Boolean variables. The exclusive or (XOR) is defined

$$A \oplus B = A \cdot \bar{B} + \bar{A} \cdot B \tag{1}$$

   where the overbar denotes the Boolean complement. Let's generalize this to when A and B are fuzzy sets with membership functions $\mu_A(x)$ and $\mu_B(x)$.

[1] Note this problem has only one antecedent and one consequent.

(a) Generate a 2D plot of the XOR in (1) using min-max fuzzy logic.

(b) Do the same for sum-product fuzzy logic.

(c) Make up and plot your own fuzzy XOR that matches boundary conditions.

(d) Consider the two membership functions in Figure 1. For the three fuzzy XOR's you've calculated, plot and label the XOR's of these two functions. Make sure your plots are carefully labelled.

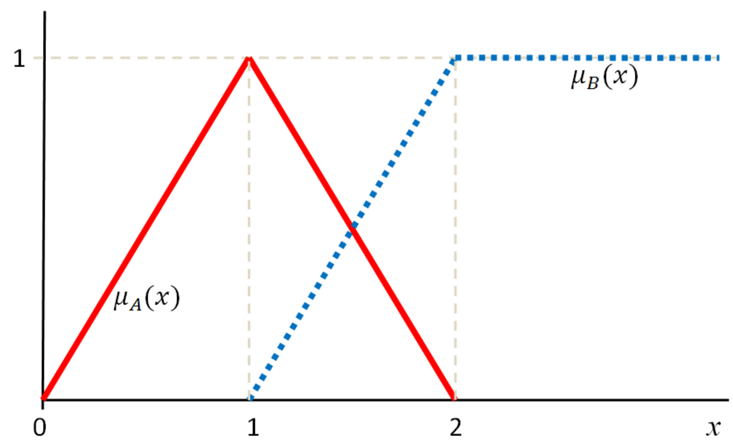

Figure 1: Figure for Problem 2.