HACETTEPE UNIVERSITY
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Fuzzy Modelling Laboratory

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5th Semester
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Academic Year 2023/2024

Exercise 5

Write a script to calculate the algebraic product and Łukasiewicz product of fuzzy sets A, B and C, which are described using Gauss membership functions:

$$\mu_A(x) = \mathrm{e}^{-\left(\frac{x-5}{2}\right)^2}$$

$$\mu_B(x) = \mathrm{e}^{-\left(\frac{x-6}{2}\right)^2}$$

$$\mu_C(x) = \mathrm{e}^{-\left(\frac{x-7}{2}\right)^2}$$

$$\mu_D(x) = prod_{Alg}(\mu_A(x), \mu_B(x), \mu_C(x))$$

$$\mu_E(x) = prod_{Luk}(\mu_A(x), \mu_B(x), \mu_C(x))$$

C1 – red	Z1 – continous line
C2 – magenta	Z2 – continous line
C3 – green	Z3 – continous line, line character „o”
C4 – blue	Z4 – continous line, line character „x”
C5 – cyan	Z5 – continous line, line character „+”
DS = 0.15	R = [0, 10]

Draw the membership functions $\mu_A(x)$, $\mu_B(x)$, $\mu_C(x)$, $\mu_D(x)$ and $\mu_E(x)$ on one graph in the range of R. Use the following colours $\mu_A(x)$ – C1, $\mu_B(x)$ – C2, $\mu_C(x)$ – C3, $\mu_D(x)$ – C4, $\mu_E(x)$ – C5, and continuous lines for each function and line characters Z1, Z2, Z3, Z4, Z5.

Sign the membership functions in the following way: $\mu_A(x)$ – MFA, $\mu_B(x)$ – MFB, $\mu_C(x)$ – MFC, $\mu_D(x)$ – MFD, $\mu_E(x)$ – MFE. Use a DS discretization step.

Write the equations describing the height and the power of a fuzzy set. Determine the height of the fuzzy sets: height(D), height(E) and the power of the fuzzy sets: card(D), card(E).

Solution

```
% algebraic product and Łukasiewicz product
x=[0:0.15:10]
ya=exp(-(((x-5)/2).^2))
yb=exp(-(((x-6)/2).^2))
yc=exp(-(((x-7)/2).^2))
yd=ya.*yb.*yc
ye_ab=max(0,ya+yb-1)
ye_abc=max(0,ye_ab+yc-1)

% plot the curves
plot(x,ya,'r',x,yb,'m',x,yc,'g-o',x,yd,'b-*',
     x,ye_abc,'c-+')
grid on
legend('MFA','MFB','MFC','MFD','MFE')

% axis, line width, font size
set(gca,'fontsize',16)
```

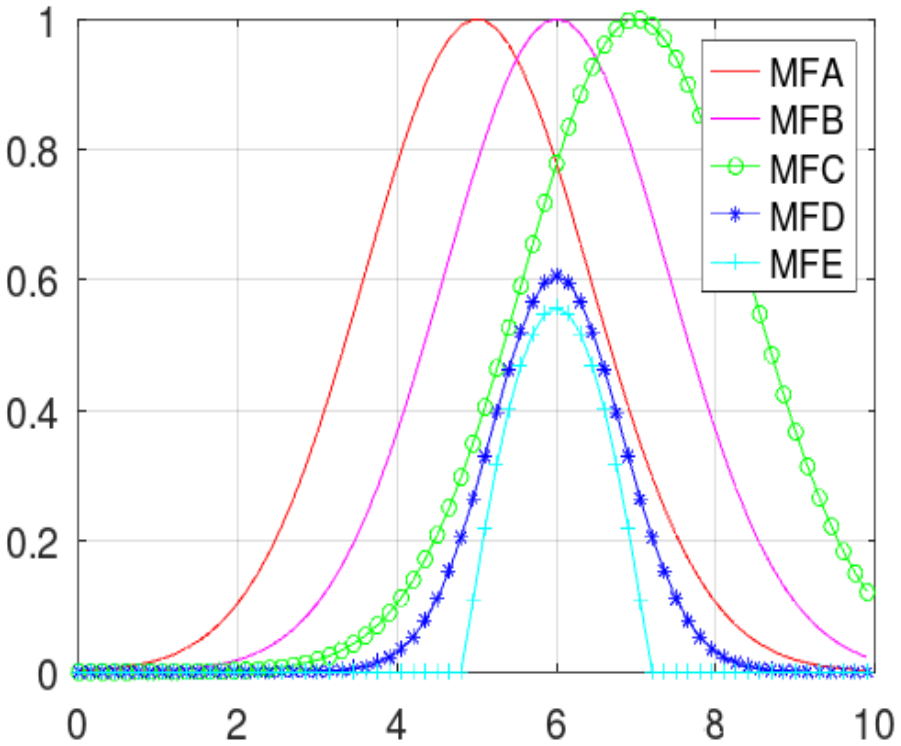

Figure 4.1: The membership functions MFA, MFB, MFC and the algebraic product MFD and the Łukasiewicz product MFD.

```
% calculate height
hD=max(yd)-min(yd)
hE=max(ye_abc)-min(ye_abc)
```

height(D) = 0.6065
height(E) = 0.5576

```
% calculate cardinal
cardD=sum(yd)
cardE=sum(ye_abc)
```

card(D) = 8.2757
card(E) = 5.7231