

# Fuzzy Modelling

## LECTURE 7

### T-norm fuzzy logics

#### Example 7.1.

The Gaussian membership functions:

$$\mu_A(x) = e^{-\left(\frac{x-8}{3}\right)^2}$$

$$\mu_B(x) = e^{-\left(\frac{x-9}{3}\right)^2}$$

$$\mu_C(x) = e^{-\left(\frac{x-10}{3}\right)^2}$$

### Algebraic product:

$$\begin{aligned}\forall x \in X : \mu_{A \cap B}(x) &= \\ &= \text{prod}(\mu_A(x), \mu_B(x)) = \\ &= \mu_A(x) \cdot \mu_B(x)\end{aligned}$$

### Lukasiewicz product:

$$\begin{aligned}\forall x \in X : \mu_{A \cap B}(x) &= \\ &= \text{prod}_{\text{Luk}}(\mu_A(x), \mu_B(x)) = \\ &= \max(0, \mu_A(x) + \mu_B(x) - 1)\end{aligned}$$

### Script:

% Gaussian membership functions

```
x1 = [0:0.15:18]
y1 = exp(-((x1-8)/3).^2)
y2 = exp(-((x1-9)/3).^2)
y3 = exp(-((x1-10)/3).^2)
```

% Algebraic product - ap, Lukasiewicz product - lp

```
ap = y1 .* y2 .* y3
lp = max(0, y1+max(0, y2+y3-1)-1)
```

**% Plot, color, parameters, line width, markersize**

```
plot(x1,y1,'g','linewidth', 1,'markersize', 10,  
     x1,y2,'c','linewidth', 1,'markersize', 10,  
     x1,y3,'m','linewidth', 1,'markersize', 10,  
     x1,ap,'b-d','linewidth', 1,'markersize', 10,  
     x1,lp,'r-o','linewidth', 1,'markersize', 10)
```

**% Axis, line width, font size, grid**

```
set(gca,'linewidth',2, 'fontsize',18)  
grid on
```

**% Legend**

```
legend ('MFA', 'MFB', 'MFC', 'MFD-AP', 'MFE-LP')
```

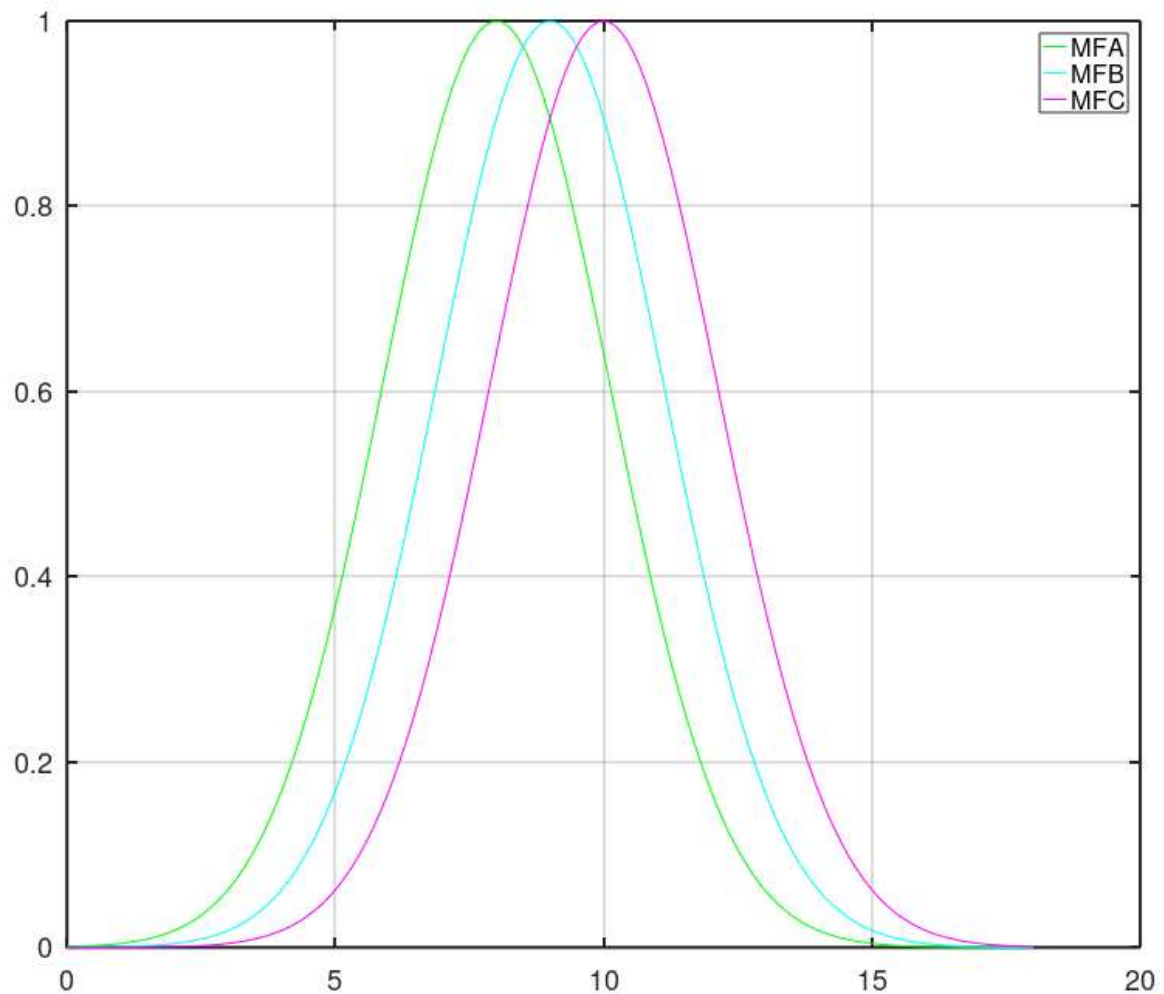


Fig. 7.1. Membership functions MFA, MFB, MFC

% Part of script

% Gaussian membership functions

$x1 = [0:0.15:18]$

$y1 = \exp(-((x1-8)/3).^2)$

$y2 = \exp(-((x1-9)/3).^2)$

$y3 = \exp(-((x1-10)/3).^2)$

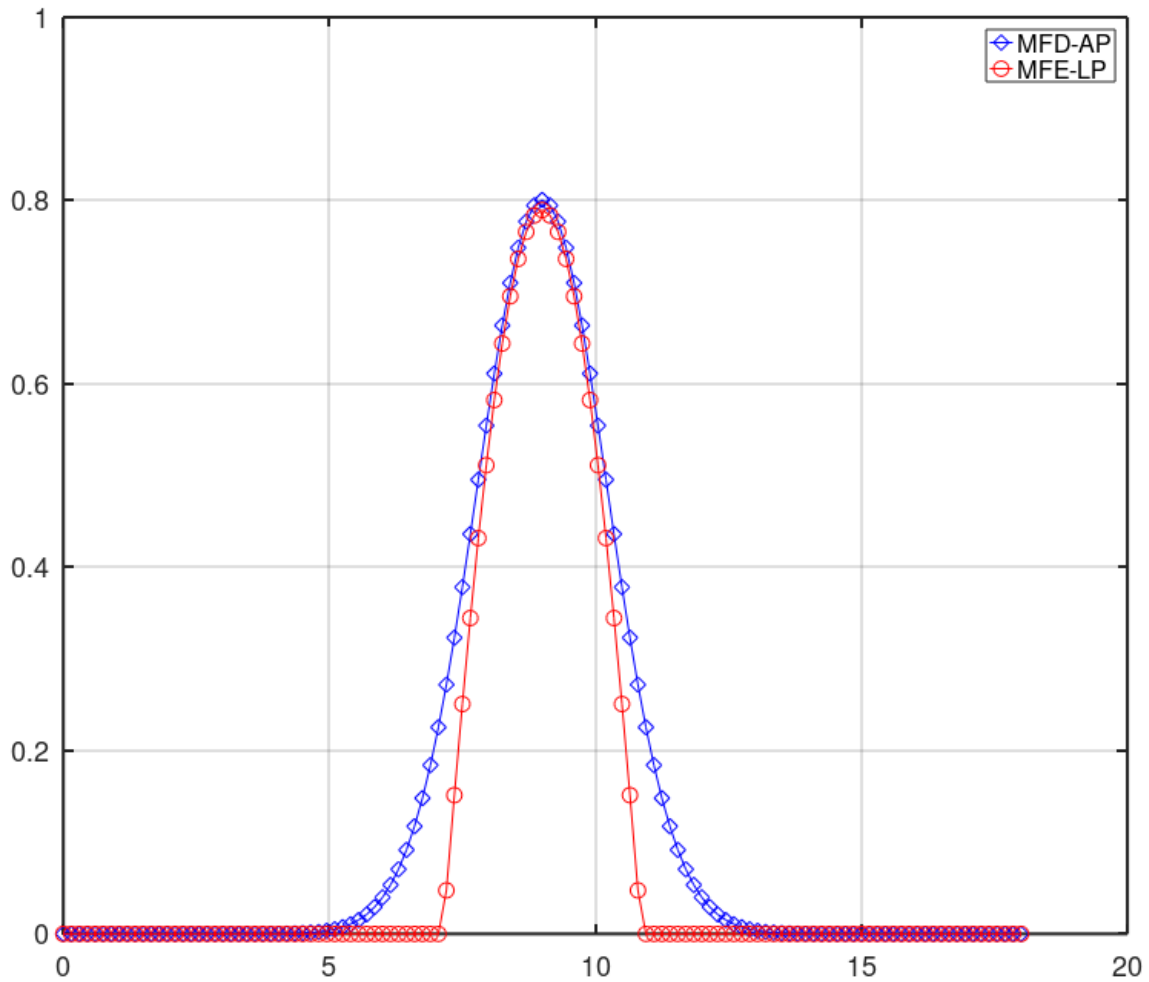


Fig. 7.2. Algebraic product MFD and Lukasiewicz product MFE

% Part of script

% Algebraic product - ap,

% Lukasiewicz product - lp

ap = y1 .\* y2 .\* y3

lp = max(0, y1+max(0, y2+y3-1)-1)

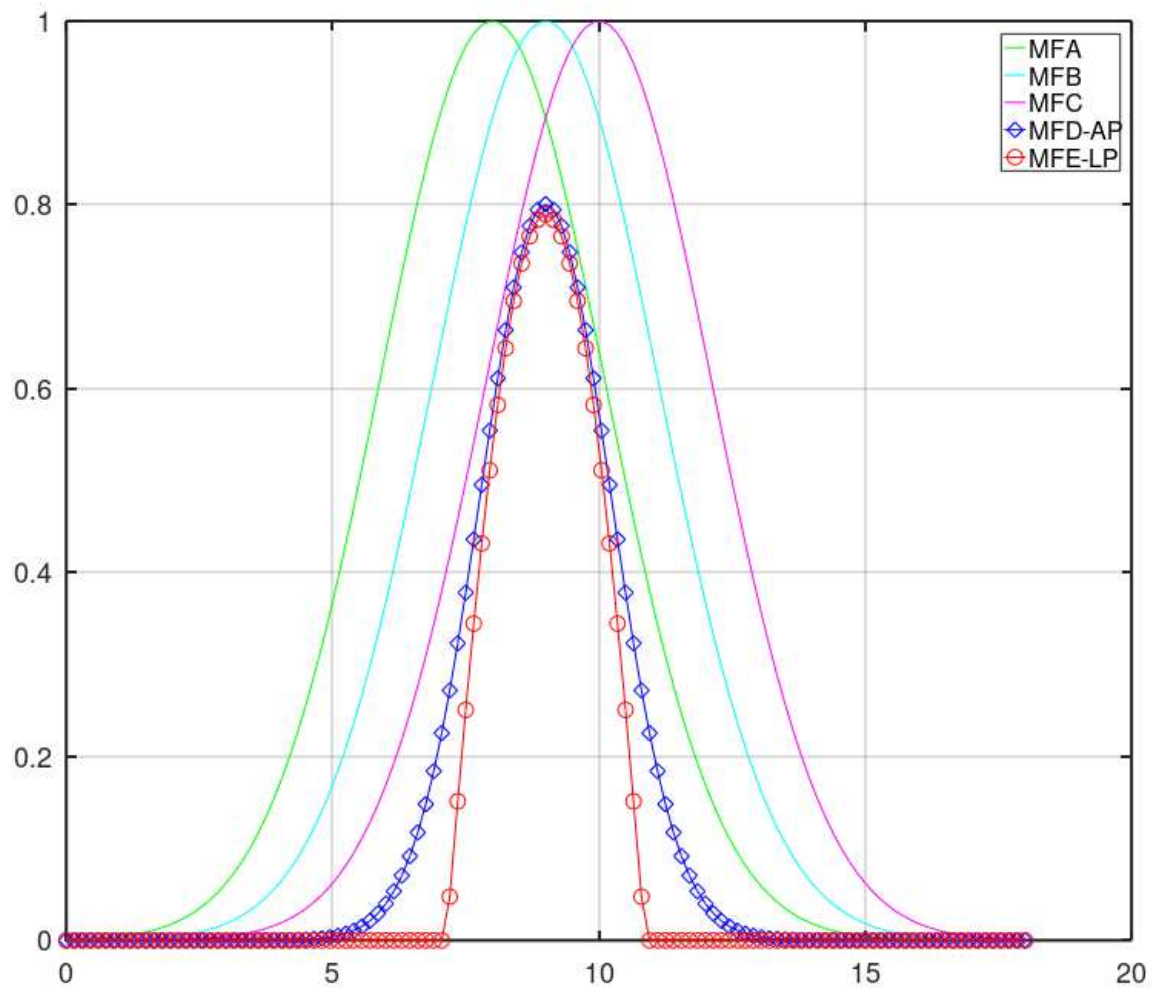


Fig. 7.3. Membership functions MFA, MFB, MFC, algebraic product MFD and Lukasiewicz product MFE