Bulanık Mantık

(MÜH 425 – Bilgisayar Müh. Böl.)

Prof.Dr. Yaşar BECERİKLİ

Hafta-4
Bulanık Kümeler- Bulanık İşlemler

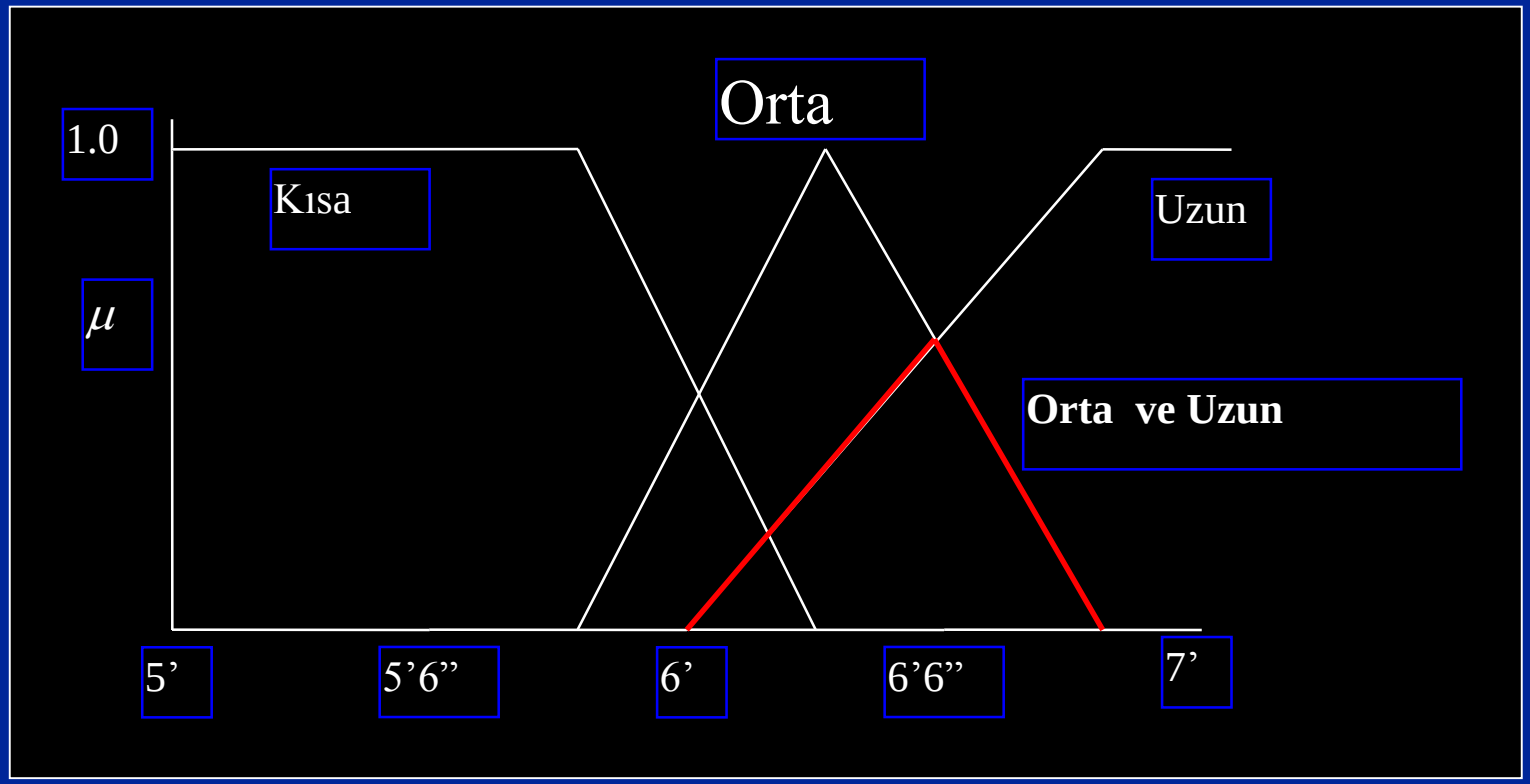
İÇERİK

- Teorinin mucidi: Lutfi Asker Zadeh
- Bulanık Mantığa Giriş
- Bulanık Kümeler
- Temel İşlemler
- Kural Tabanı
- Bulandırma, Durulama
- Üyelik Fonksiyonları
- Çıkartım Sistemleri
- FAM tablosu,
- Uygulamalar

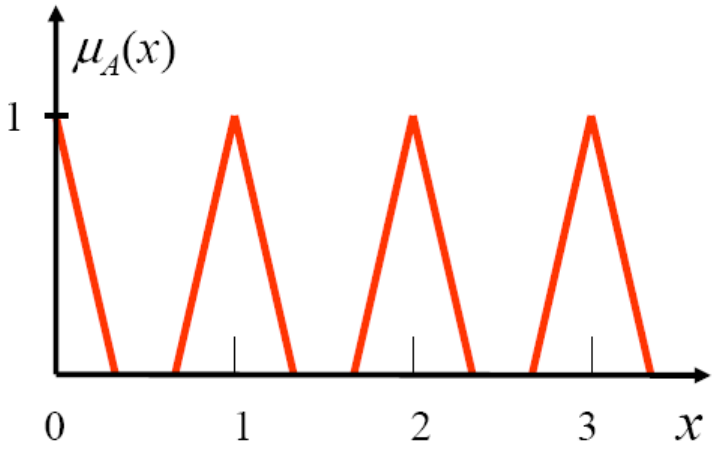
Kesişim (t-normu tipi)

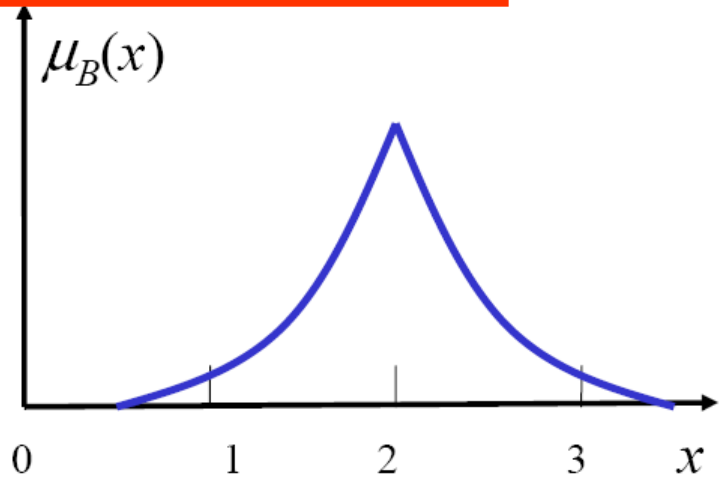
$$\mu_{A.B}(x) = \mu_{A \cap B}(x) = \min(\mu_A(x), \mu_B(x))$$

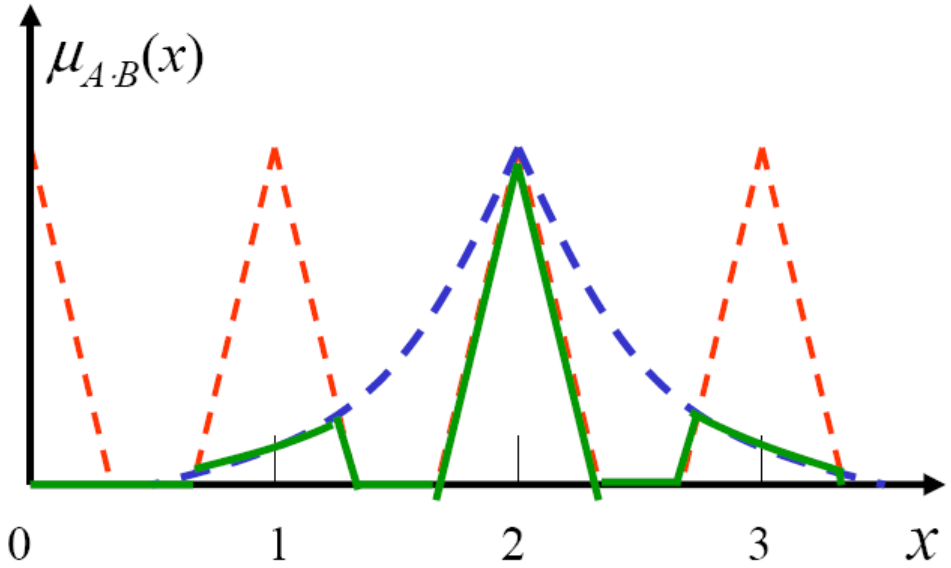
- Örnek: Orta ve Uzun



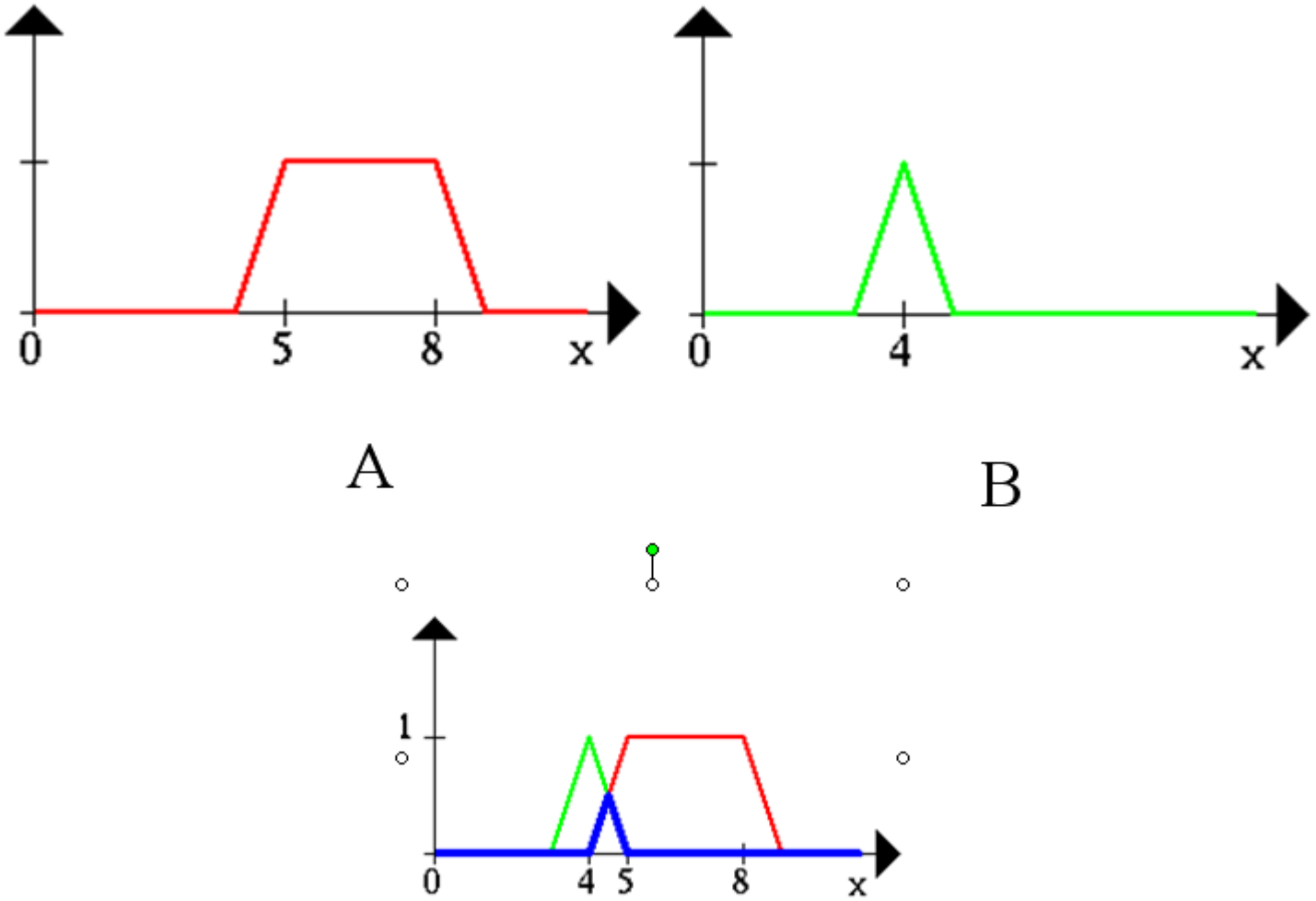
$$\mu_{A.B}(x) = \min(\mu_A(x), \mu_B(x))$$





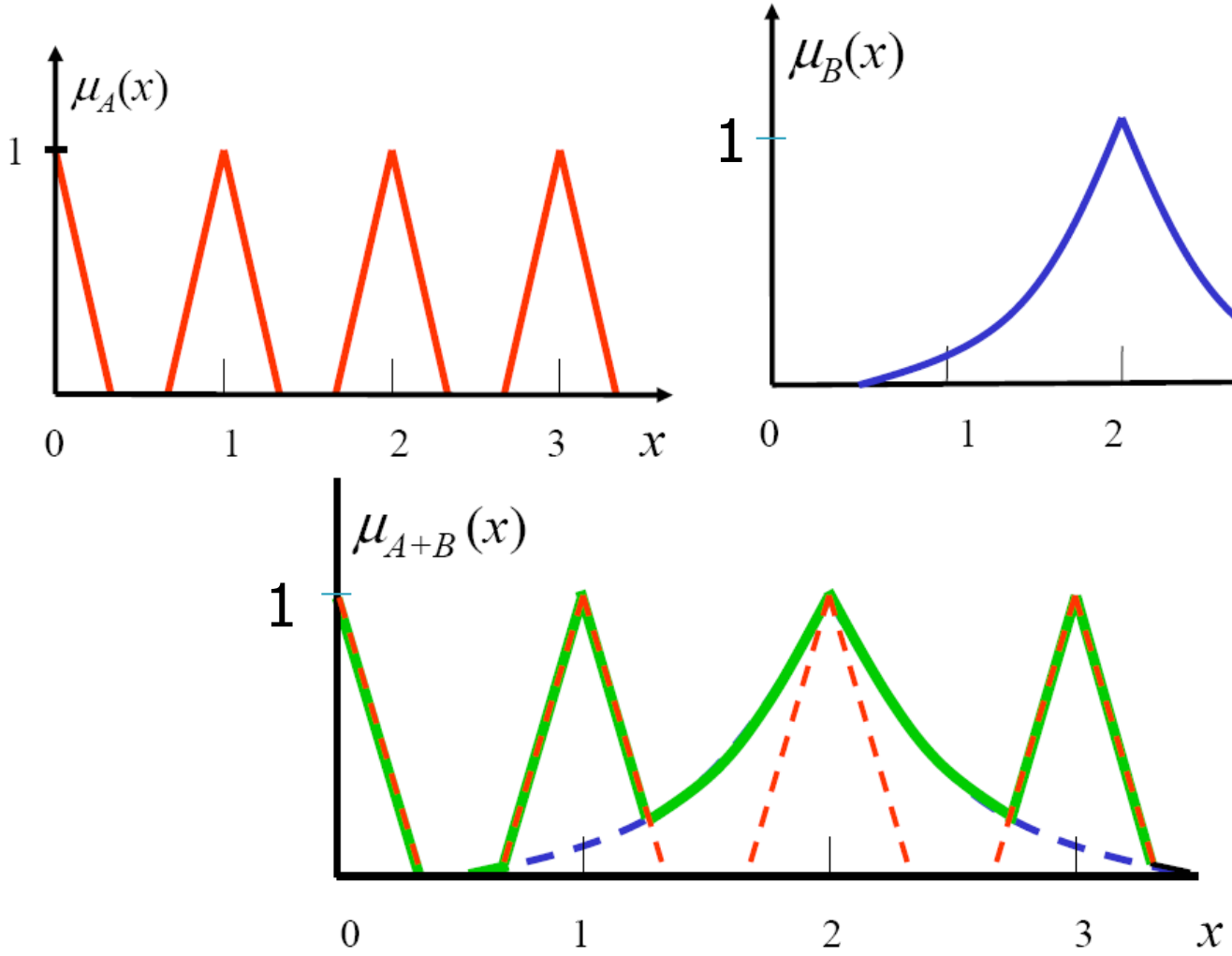


$$\mu_{A.B}(x) = \min(\mu_A(x), \mu_B(x))$$

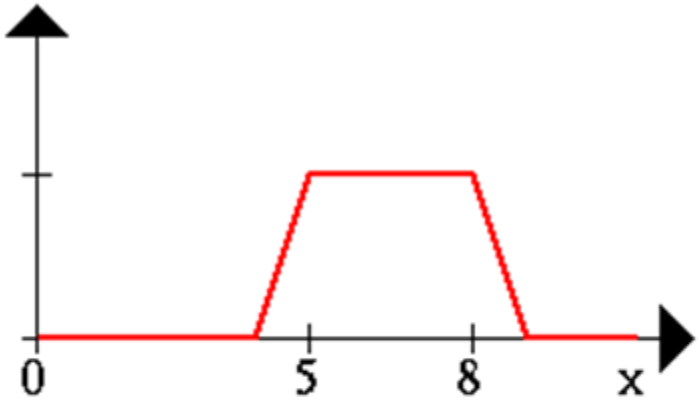


Birleşim (s-normu tipi)

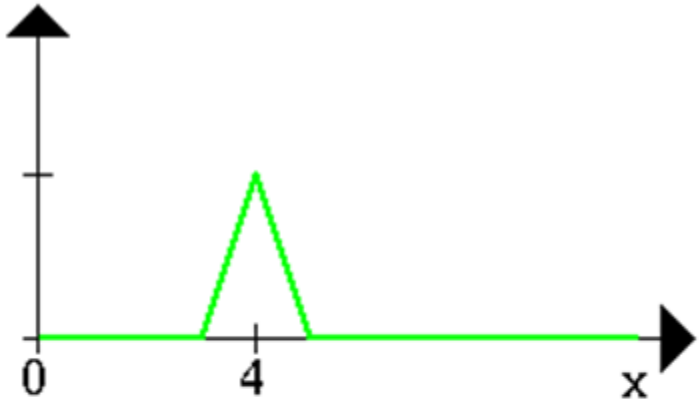
$$\mu_{A+B}(x) = \mu_{A \cup B}(x) = \max(\mu_A(x), \mu_B(x))$$



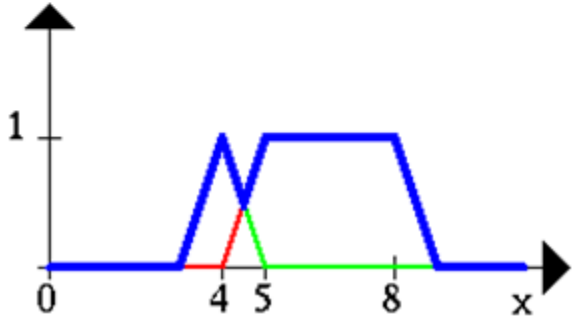
$$\mu_{A+B}(x) = \max(\mu_A(x), \mu_B(x))$$



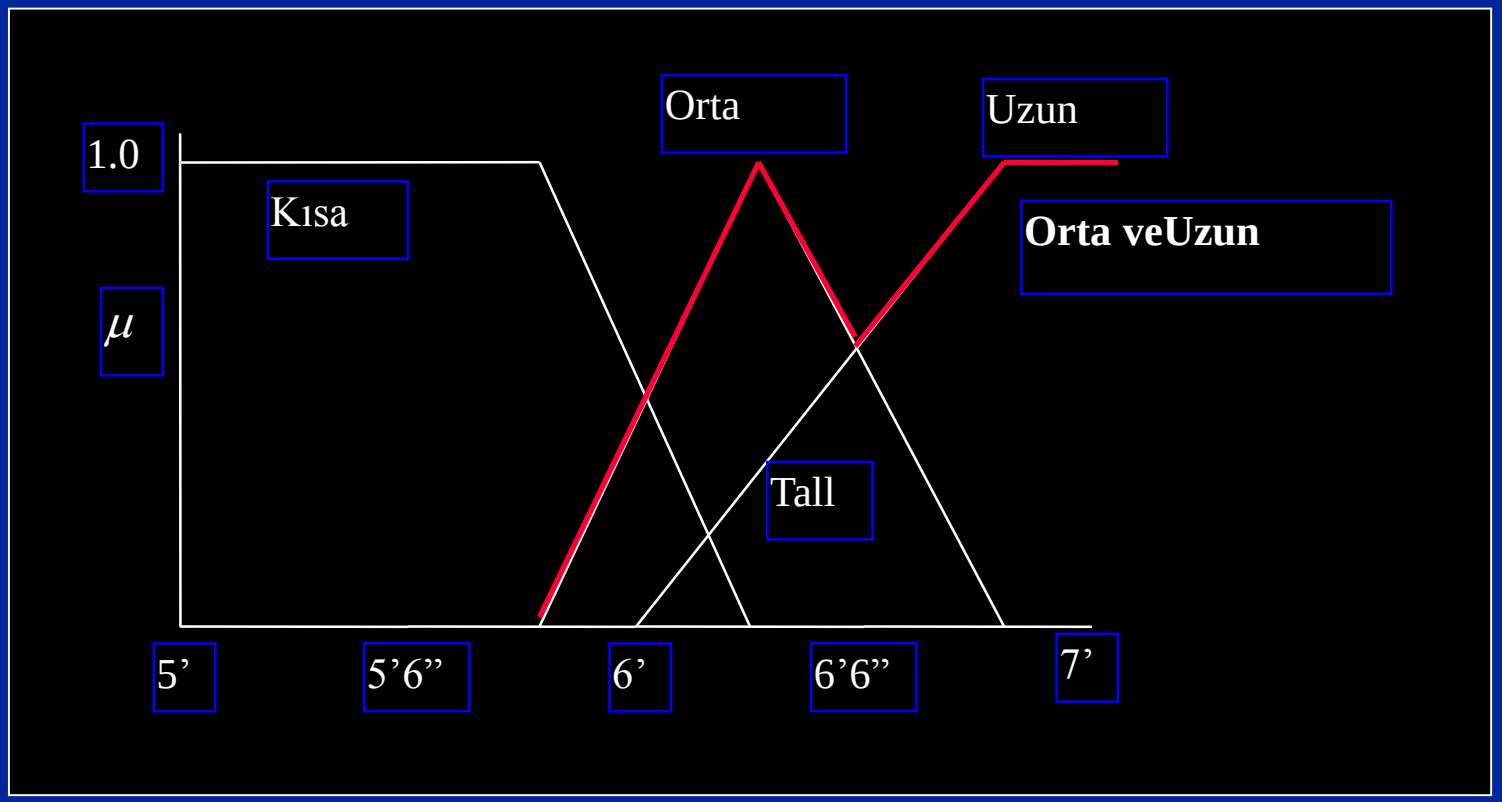
A



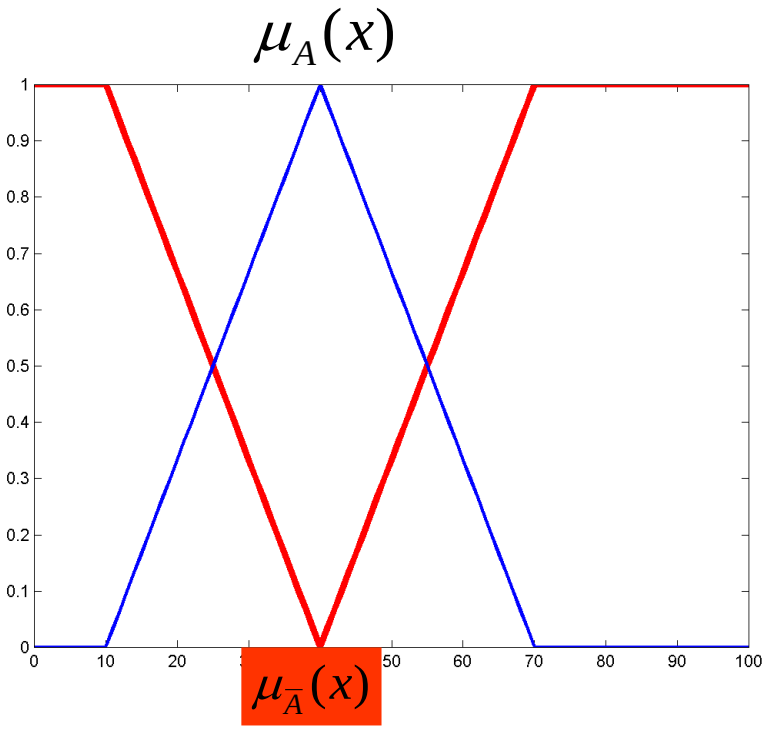
B

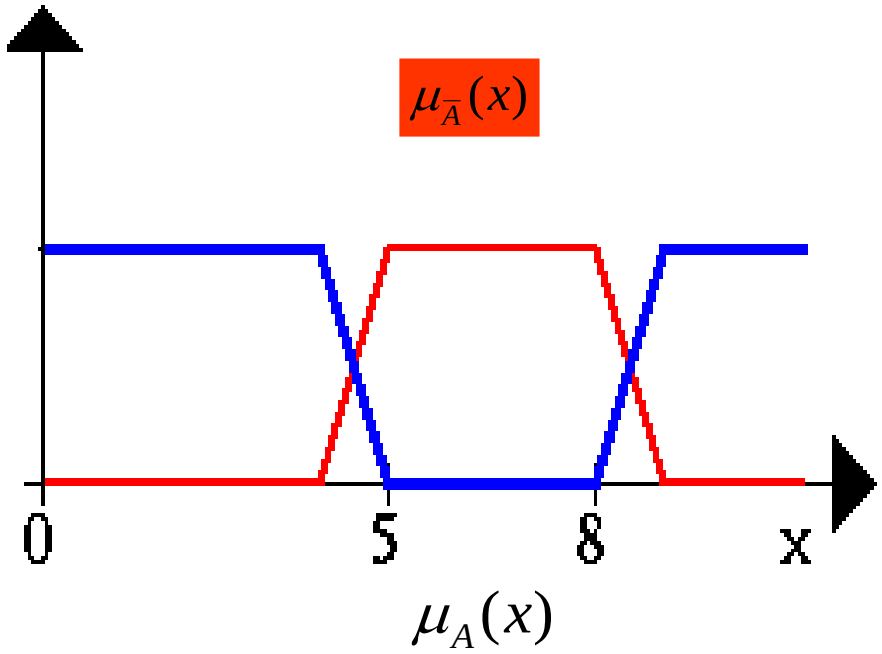


$$\mu_{A+B}(x) = \max(\mu_A(x), \mu_B(x))$$



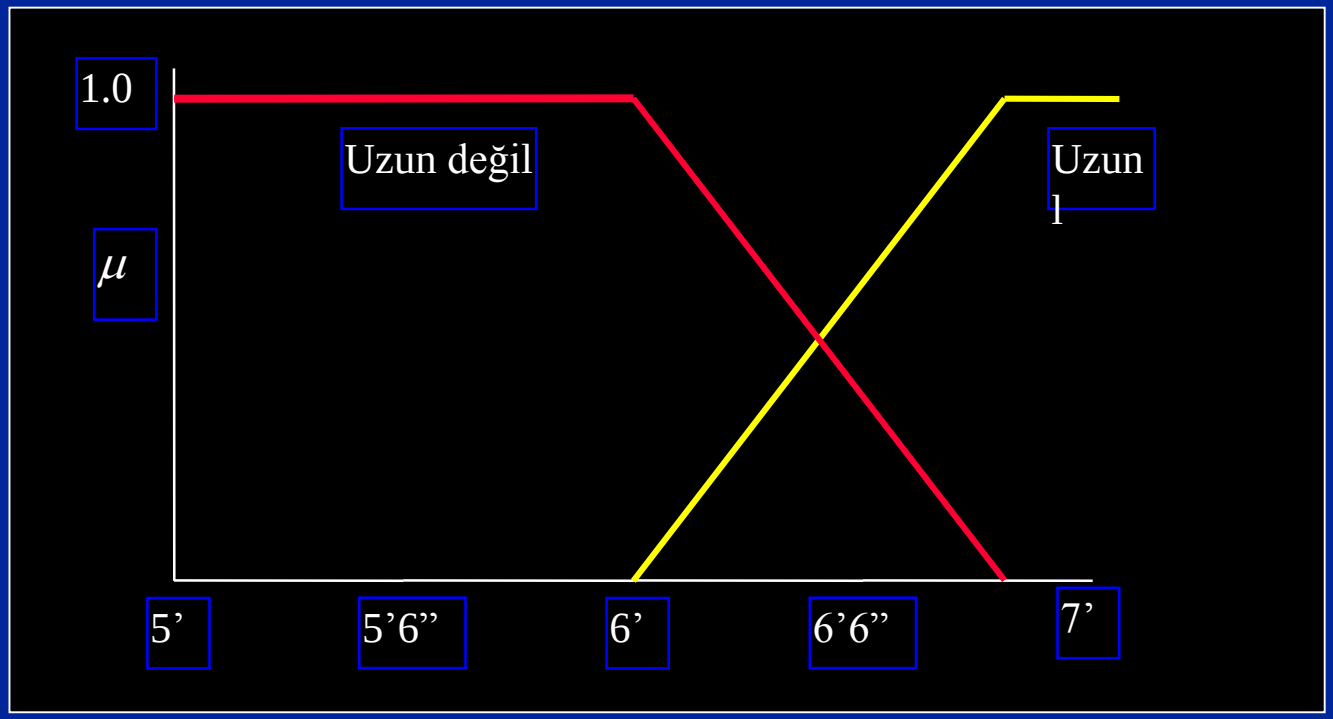
$$\mu_{\bar{A}}(x) = 1 - \mu_A(x)$$





$$\mu_{\bar{A}}(x) = 1 - \mu_A(x)$$

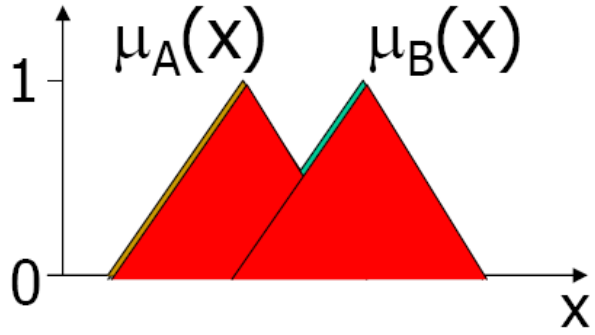
Tümleme (Negation:) $\mu_{\bar{A}}(x) = 1 - \mu_A(x)$



Bulanık Mantık İşlemleri

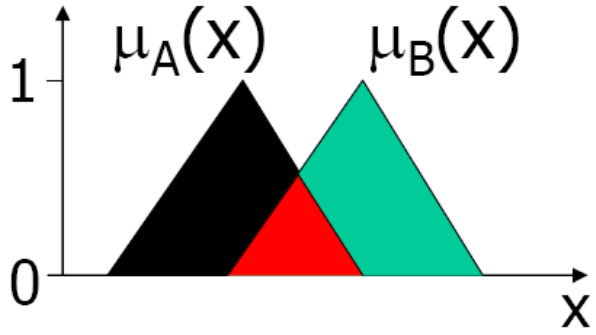
Union

$\mu_{A\vee B}(x)=\max\{\mu_A(x),\mu_B(x)\}$

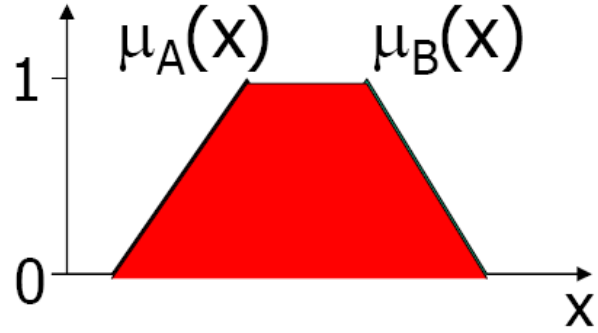


Intersection

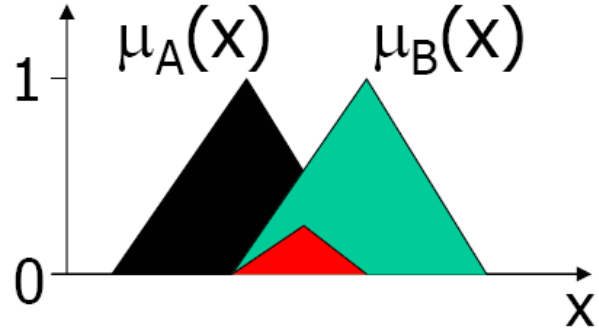
$\mu_{A\wedge B}(x)=\min\{\mu_A(x),\mu_B(x)\}$



$\mu_{A\vee B}(x)=\min\{1,\mu_A(x)+\mu_B(x)\}$



$\mu_{A\wedge B}(x)=\mu_A(x)\bullet\mu_B(x)$



Bulanık Mantıkta AND (t-normu) işlemleri

$$\mu_A(x) \cdot \mu_B(x)$$

$$\frac{\mu_A(x) \cdot \mu_B(x)}{\mu_A(x) + \mu_B(x) - \mu_A(x) \cdot \mu_B(x)}$$

$$\max\{0, \mu_A(x) + \mu_B(x) - 1\}$$

$$\frac{\mu_A(x) \cdot \mu_B(x)}{2 - [\mu_A(x) + \mu_B(x) - \mu_A(x) \cdot \mu_B(x)]}$$

Bulanık Mantıkta OR (s-normu) işlemleri

$$\mu_A(x) + \mu_B(x) - \mu_A(x) \cdot \mu_B(x)$$

$$\frac{\mu_A(x) + \mu_B(x) - 2\mu_A(x) \cdot \mu_B(x)}{1 - \mu_A(x) \cdot \mu_B(x)}$$

$$\frac{\mu_A(x) + \mu_B(x)}{1 + \mu_A(x) \cdot \mu_B(x)]}$$

$$\min\{1, \mu_A(x) + \mu_B(x)\}$$

4. Hafta

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IF-THEN (EĞER-İSE) KURALLARI

if <bulanık önerme>, then <bulanık önerme>

"x, A ise (ve) y, B ise" ; $A \cap B$

$\mu_{A \cap B} = t(\mu_A(x), \mu_B(y))$ → $\min(\mu_A, \mu_B)$; $\mu_A \cdot \mu_B$; diğer

"x, A ise (veya) y, B ise" ; $A \cup B$

$\mu_{A \cup B} = s(\mu_A(x), \mu_B(y))$ → $\max(\mu_A, \mu_B)$; $\mu_A + \mu_B - \mu_A \cdot \mu_B$; diğer.

"x, A değil ise", ⇒ DEĞİL

$\mu_{\overline{A}}(x) = d(\mu_A(x)) = 1 - \mu_A(x)$

Örnek: "(x_1 A ise ve x_2 B değilse) veya x_3 C ise" önermesini yazalım.

$s\left[t(\mu_A(x_1), d(\mu_B(x_2))), \mu_C(x_3)\right]$

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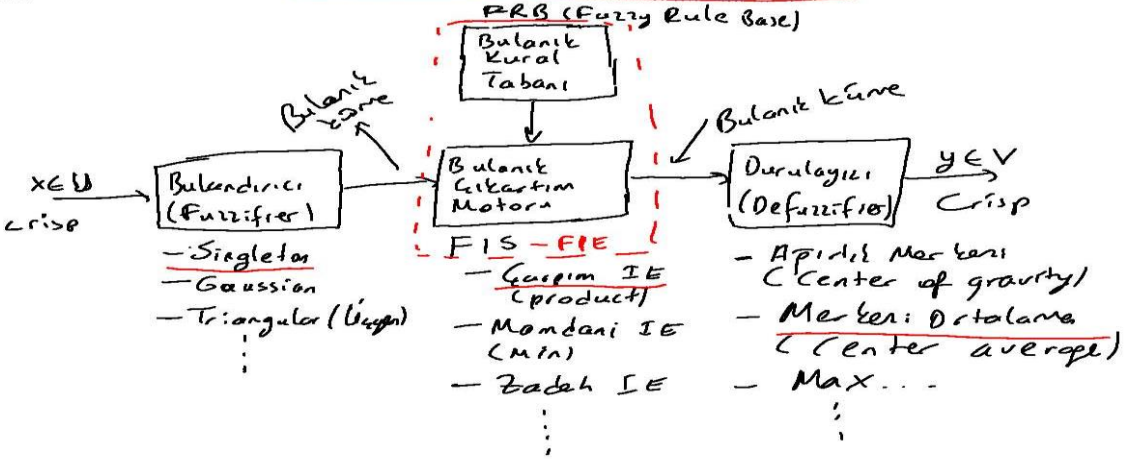
Genel Bulanık Sistem Yapısı



Standart Bulanık Sistem: (SBS) Singleton Bulandırıcı, Çarpım IE ve Merkez Ortalama Durulayıcı kullanan Bulanık Sisteme denir.

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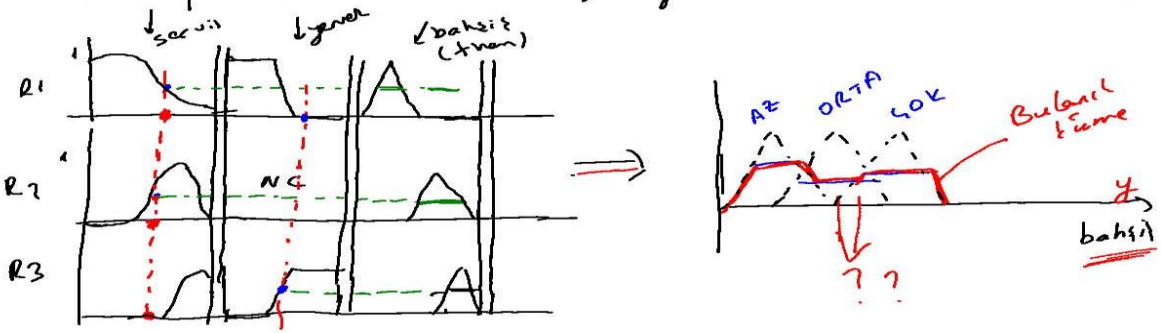
Bulanık Çıkarım Motoru (FIS-FIE)

(Sonuç Çıkarımı)

R1 : Eğer servis KÖTÜ veya yemek BAYAT ise bahşiş AZ.

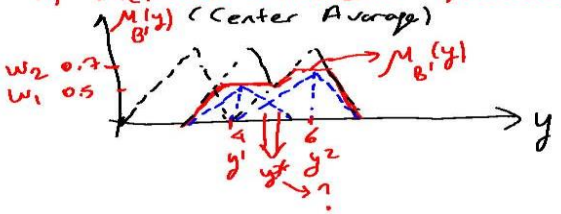
R2 : if servis ORTA then bahşiş ORTA

R3 : Eğer servis İYİ veya yemek GÜZEL ise bahşiş ÇOK



DURULAMA

1.) Merkezi Ortalama Metodu:



$$y^* = \frac{6 \cdot 0.5 + 6 \cdot 0.7}{0.5 + 0.7} = 5.16$$

Genel olarak:

$$y^* = \frac{y^1 \cdot w_1 + y^2 \cdot w_2 + \cdots}{w_1 + w_2 + \cdots} = \frac{\sum_{l=1}^{M} y^l \cdot w_l}{\sum_{l=1}^{M} w_l}$$

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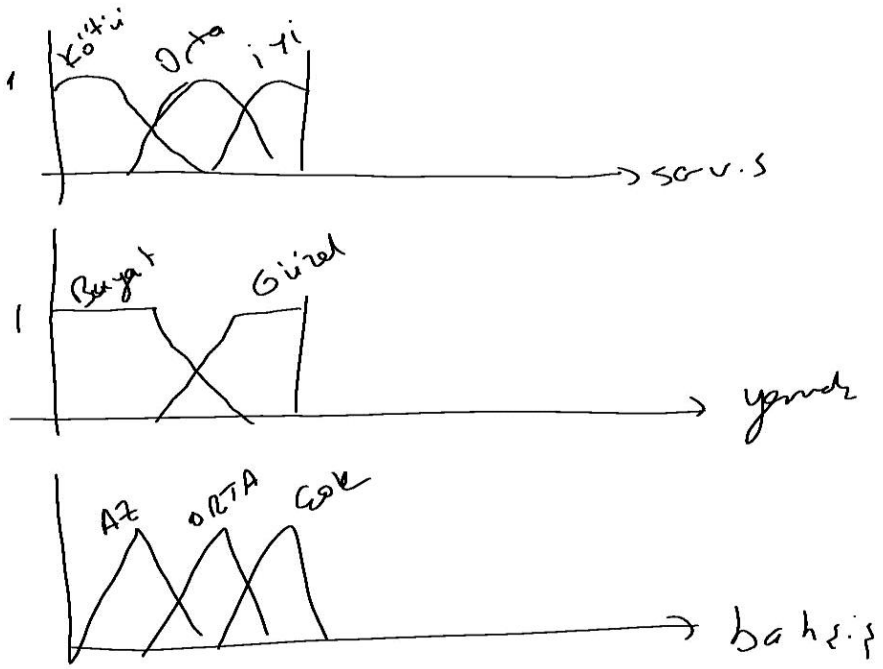

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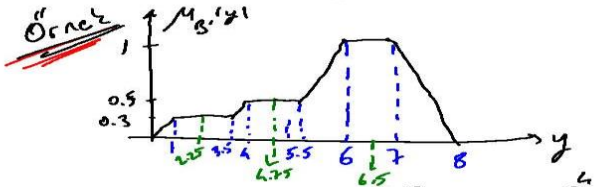
2. Ağırlık Merkezi Metodu (Center of Gravity)

$$y^* = \frac{\int_{B'} y \cdot \mu_{B'}(y)\, dy}{\int_{B'} \mu_{B'}(y)\, dy}$$:Genel Formül

Örnek



a) Merkezi ortalamayla

$$y^* = \frac{2.25 \times 0.3 + 4.75 \times 0.5 + 6.5 \times 1}{0.3 + 0.5 + 1} = 5.27$$

b) Ağırlık Merkezi Yöntemi ile

$$y^* = \frac{\int_0^1 y(0.3y)\,dy + \int_1^{3.5} y \cdot 0.3\,dy + \int_{3.5}^{4} y\,\frac{2}{5}(y-\frac{11}{2})\,dy + \int_4^{5.5} y \cdot 0.5\,dy + \int_{5.5}^{6} y\,(y-5)\,dy + \int_6^7 y \cdot 1\,dy + \int_7^8 y\,(8-y)\,dy}{\int_0^1 0.3y\,dy + \int_1^{3.5} 0.3\,dy + \int_{3.5}^{4} \frac{2}{5}(y-\frac{11}{2})\,dy + \int_4^{5.5} 0.5\,dy + \int_{5.5}^{6} (y-5)\,dy + \int_6^7 1\,dy + \int_7^8 (8-y)\,dy} = 4.9$$

5.Hafta
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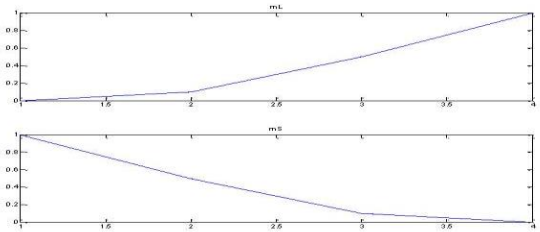
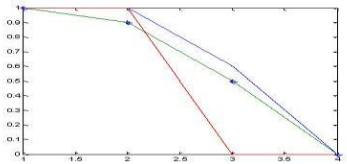
27.10.2009

Örnek Matlab.

```
u=1:4;   L=[0  0.1  0.5  1];
v=1:4;   S=[1  0.5  0.1  0];
```





```
clear;

u=1:4; v=1:4;
L=[0 0.1 0.5 1]; S=[1 0.5 0.1 0];
subplot(2,1,1);
plot(u,L);
title('mL');
subplot(2,1,2);
plot(v,S);
title('mS');
pause;
mD=max(1-L,S);
mL=min(1,1-L+S);
mz=max(min(L,S),1-L);
mG=L<S;
close
plot(u,mD,'*',u,mL,u,mz,u,mG);

pause
```

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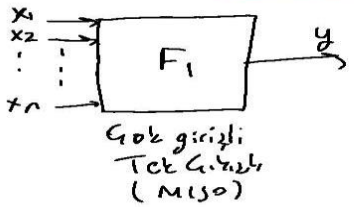
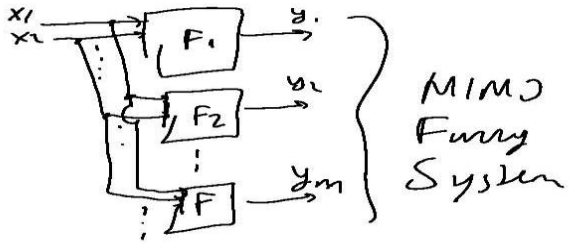
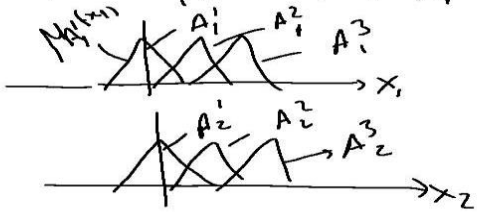
Kural Tabanlarının Oluşturulması

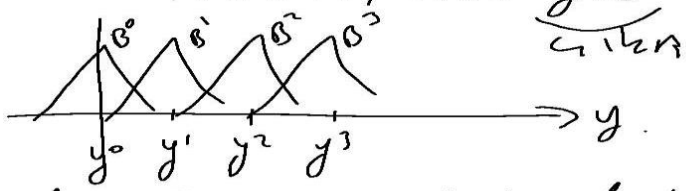




Kurallar: (Genel l. kural)

R^l = (IF x_1 is A_1^l and) ----- and (x_n is A_n^l) THEN $y = B^l$





Çıkış

B^l; [0,1] aralığında merkezler: y^l olan üyelik fonk.

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SBS (Standart Bulanık Sistem) : { Singleton fuzzifier
product IE
center average defuzzifier.

x_i 'ler girişler olmak üzere bir SBS "nonlinear mapping" yapar. Ve bu ifade;

$$f(x) = \frac{\sum_{l=1}^{M} y^l \prod_{i=1}^{n} \mu_{A_i^l}(x_i)}{\sum_{l=1}^{M} \prod_{i=1}^{n} \mu_{A_i^l}(x_i)} = \sum_{l=1}^{M} y^l \cdot \phi^l(x)$$

(kural sayısı)

A_i^l : i. değişkenin l. üyelik fonk.

→ taban (bazis) fonk. (ϕ^l)

NOT: $p_i(x)$: polinom fonk. olsun. Herhangi bir $f(x)$ fonk $p_i(x)$ 'ler cinsinden ;

$$f(x) \cong \sum_{i=1}^{N} c_i p_i(x)$$

yazılabilir. $(x \in [a,b])$

Eğer $p_i(x)$ 'ler ortanormal ise; (dik+normal)

$$c_i = \langle f(x), p_i(x) \rangle = \int_a^b f(x) p_i(x) dx$$

← iç çarpım

Trigonometrik Fourier Serisi :

$$f(x) = \sum_{n=0}^{\infty} a_n \cos nx + b_n \sin nx$$