

Redes Neuronales

Adaptive-Network-Based
Fuzzy Inference Systems
(redes ANFIS)



Profe: Pancho Tamarit
Alumno: Carlos Budde

Redes Neuronales: ANFIS

Aspectos principales de estas redes

- ▶ tienen la arquitectura de un perceptrón, con saltos conectivos entre capas
- ▶ en la primera capa de neuronas usa los conceptos de la lógica difusa
- ▶ son funcionalmente equivalentes a los *sistemas de inferencia difuso*, como el de Takagy-Sugeno

Redes Neuronales: ANFIS

Concepto de lógica difusa

- "Esta goma es blanca"
- "Y... sí"



color_{blanco} (*Maped*) = 1

Redes Neuronales: ANFIS

Concepto de lógica difusa

- "Esta goma es blanca"
- "Mmm... más o menos"

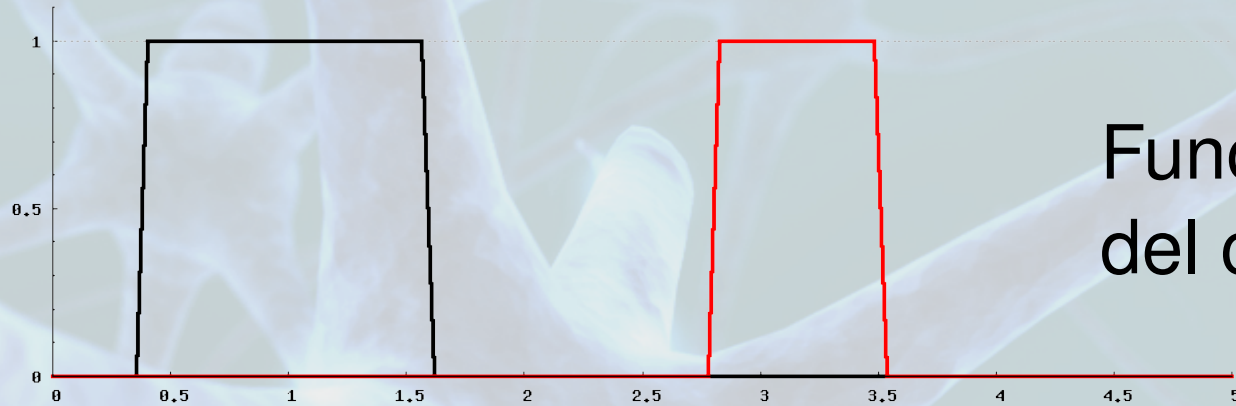


$\text{color}_{\text{blanco}}(\textit{Faber-Castell}) = 0.65$

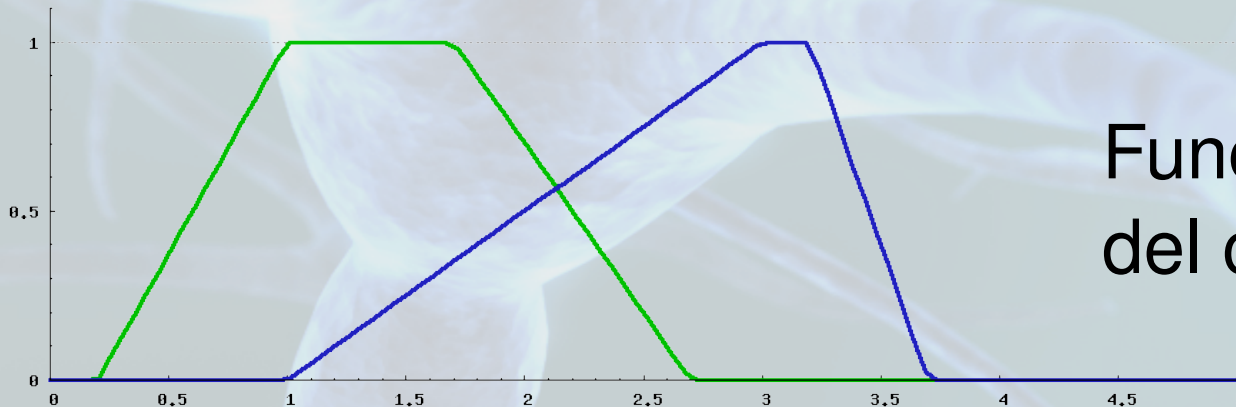
$\text{color}_{\text{gris}}(\textit{Faber-Castell}) = 0.35$

Redes Neuronales: ANFIS

Concepto de lógica difusa

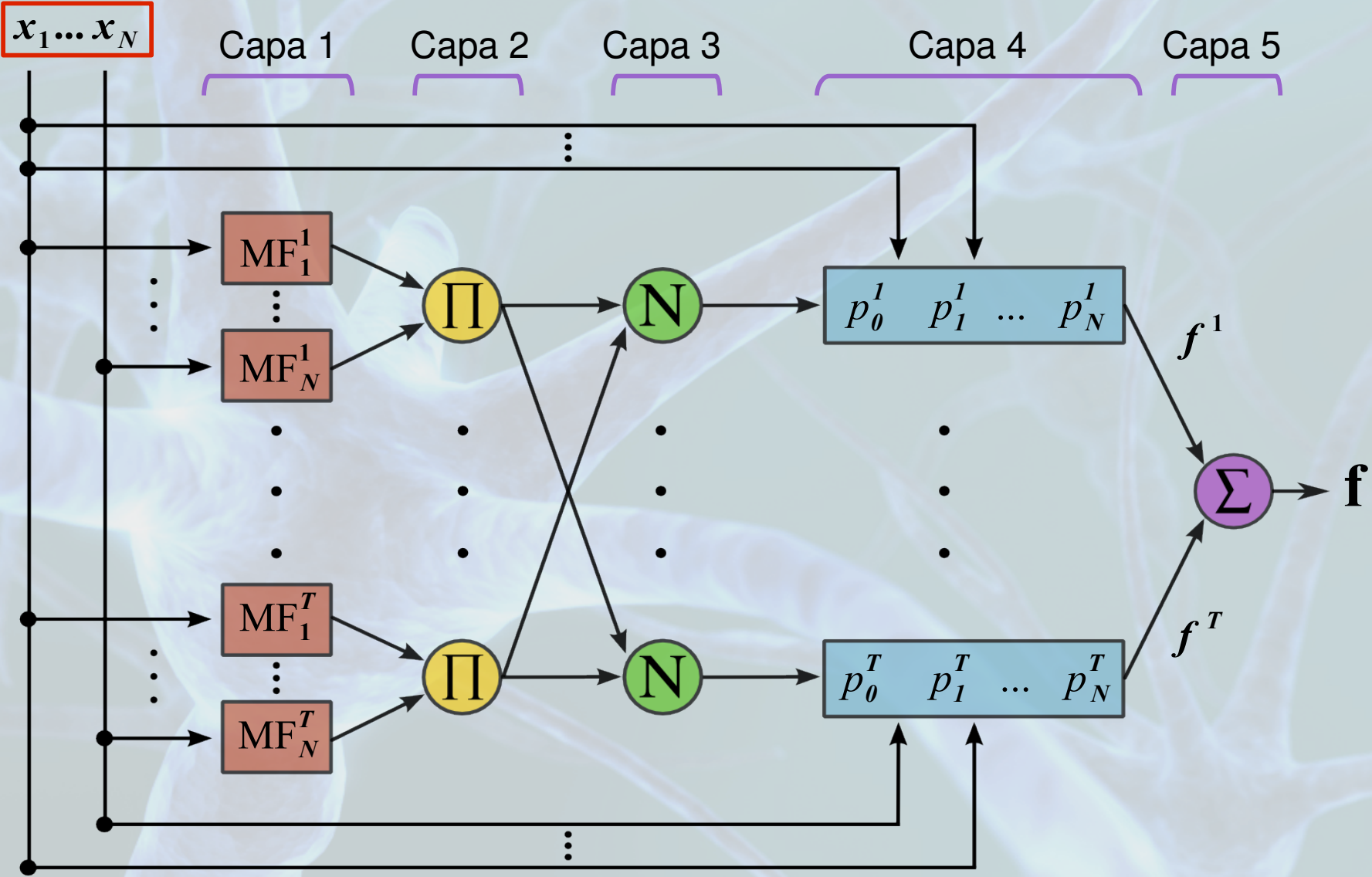


Funciones membresía
del caso “**crisp**”



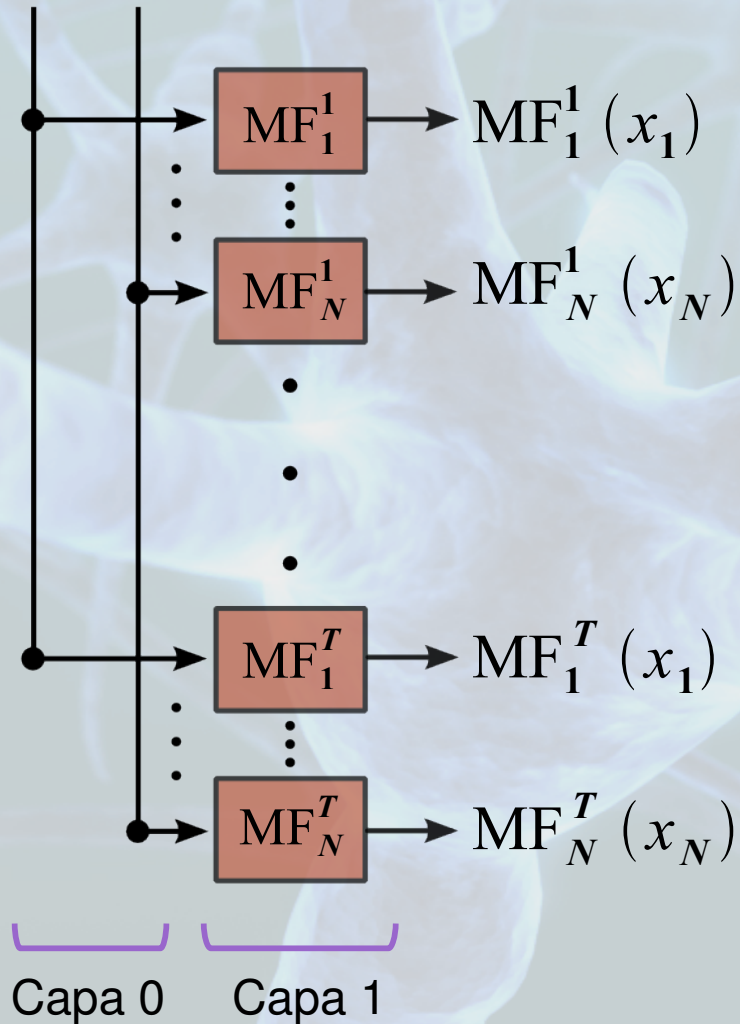
Funciones membresía
del caso “**difuso**”

Redes Neuronales: ANFIS

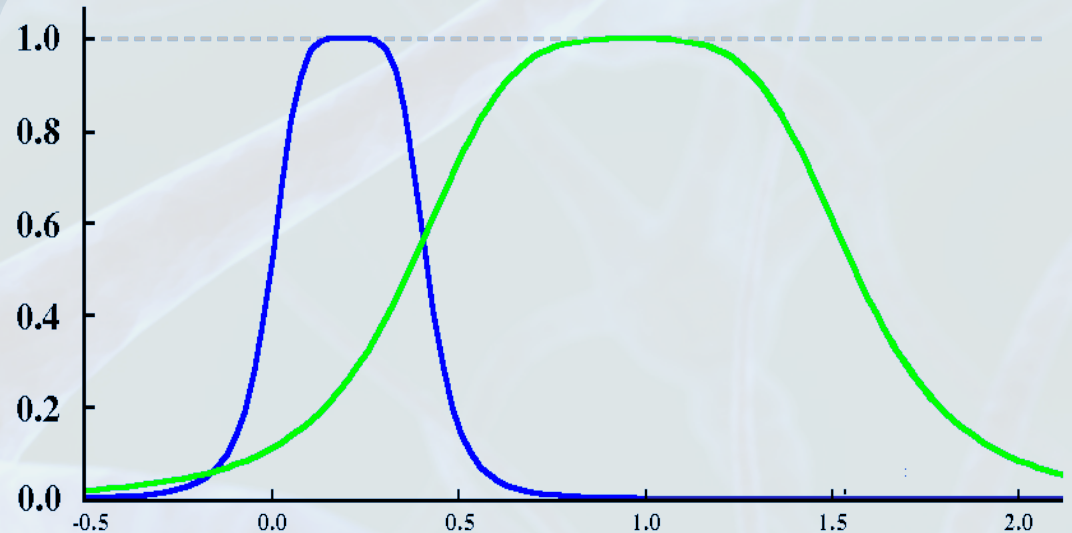


Redes Neuronales: ANFIS

$x_1 \dots x_N$

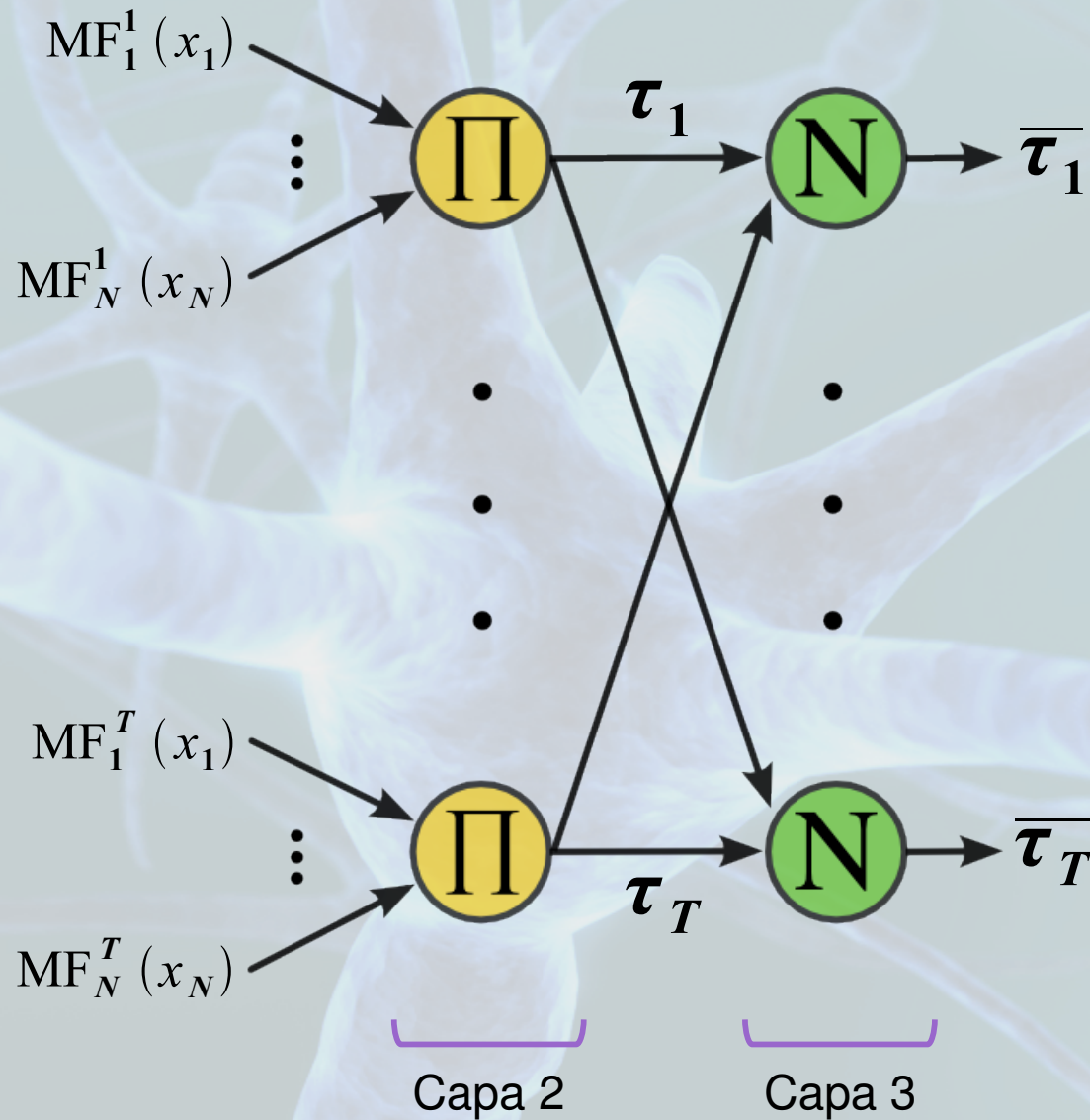


Funciones membresía tipo ***bell***



$$MF_{a,b,c}(x) = \frac{1}{1 + \left| \frac{x-c}{a} \right|^{2b}}$$

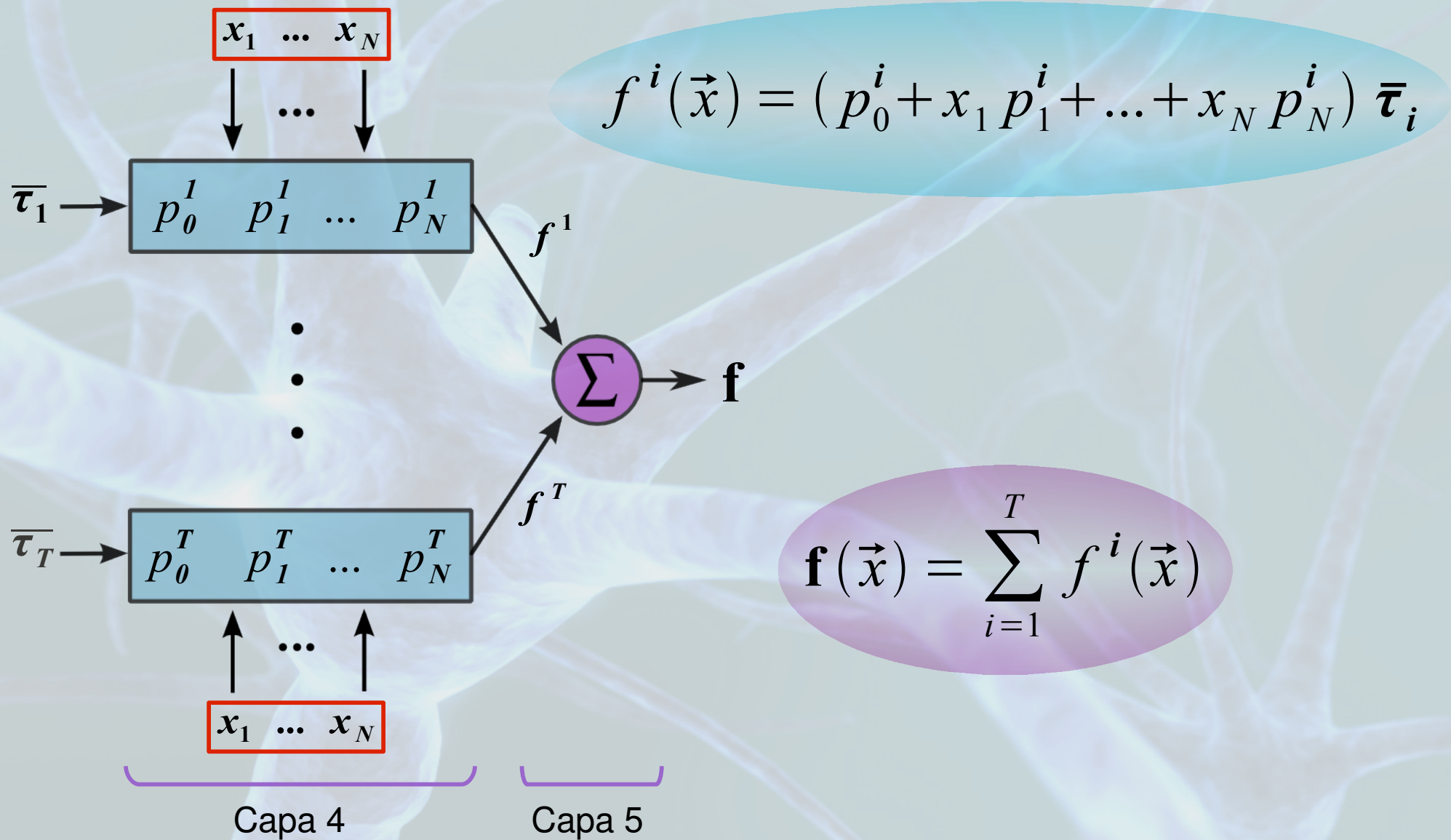
Redes Neuronales: ANFIS



$$\tau_i(\vec{x}) = \prod_{j=1}^N MF_j^i(\vec{x})$$

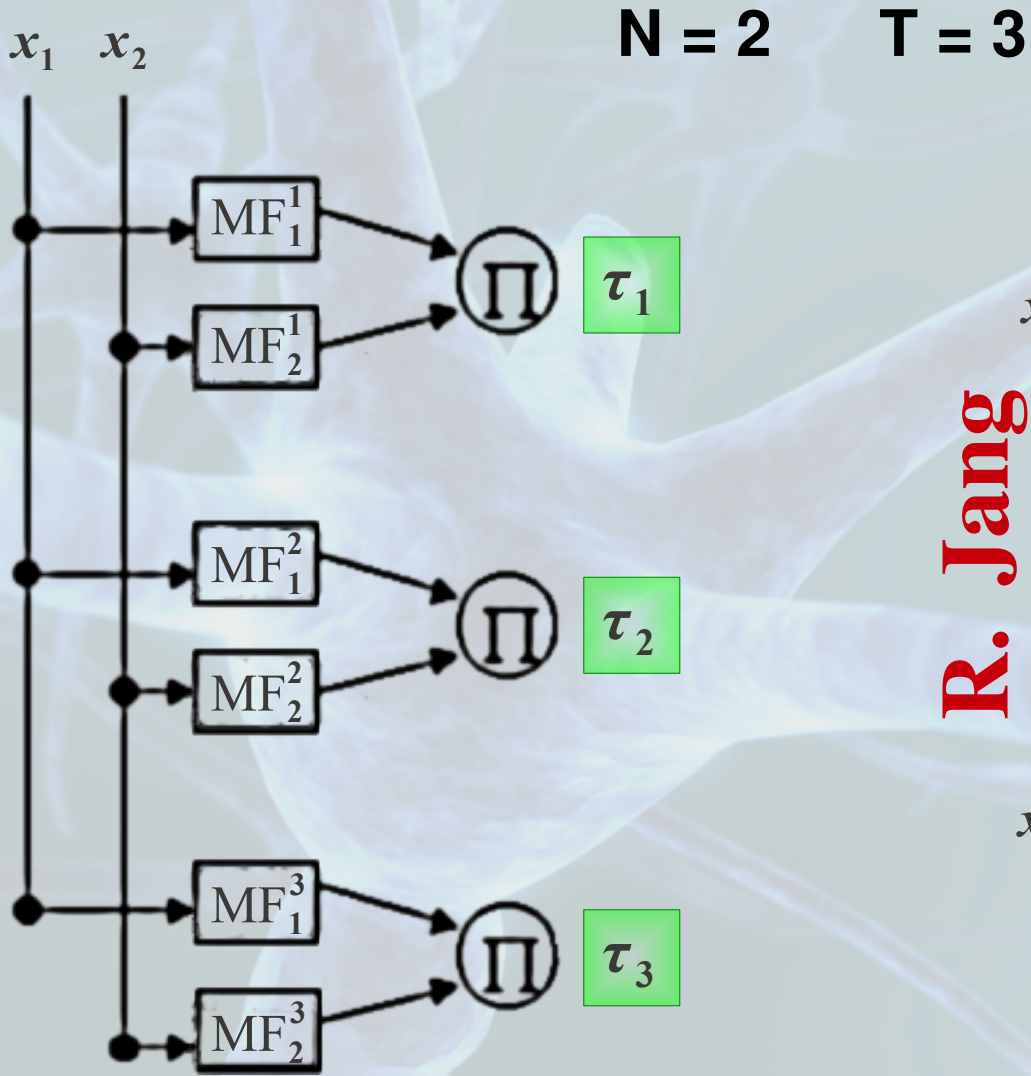
$$\bar{\tau}_i(\vec{x}) = \frac{\tau_i(\vec{x})}{\sum_{j=1}^T \tau_j(\vec{x})}$$

Redes Neuronales: ANFIS

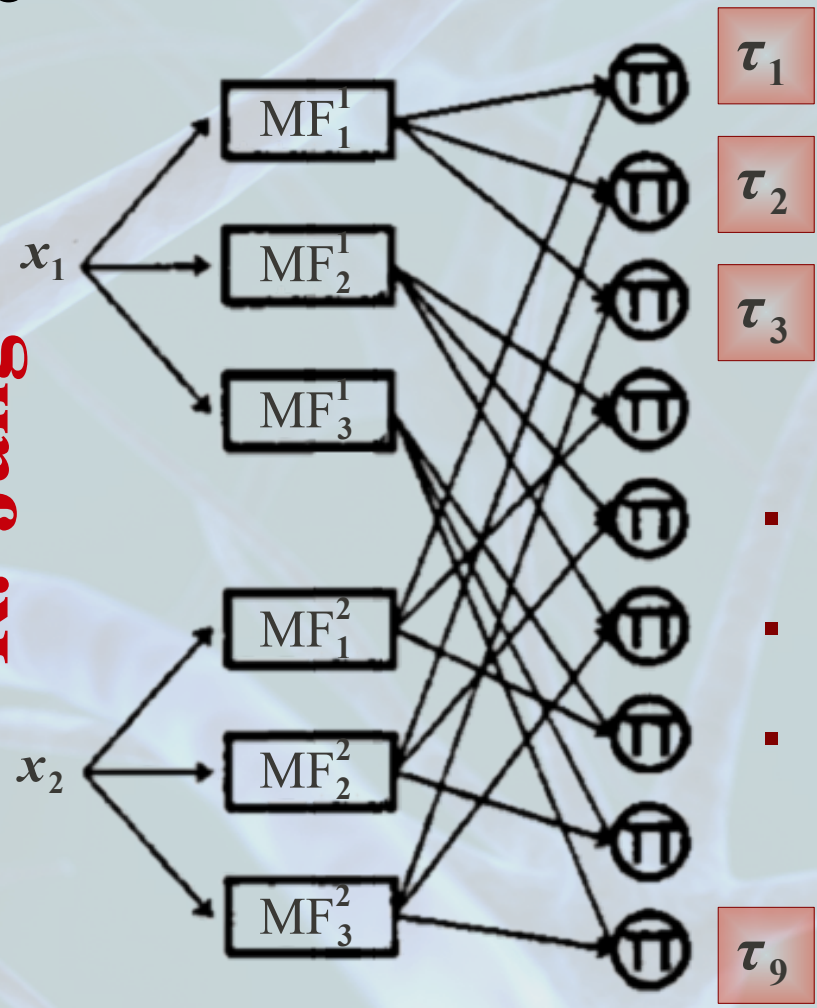


Redes Neuronales: ANFIS

N. Bruno



R. Jang



Redes Neuronales: ANFIS

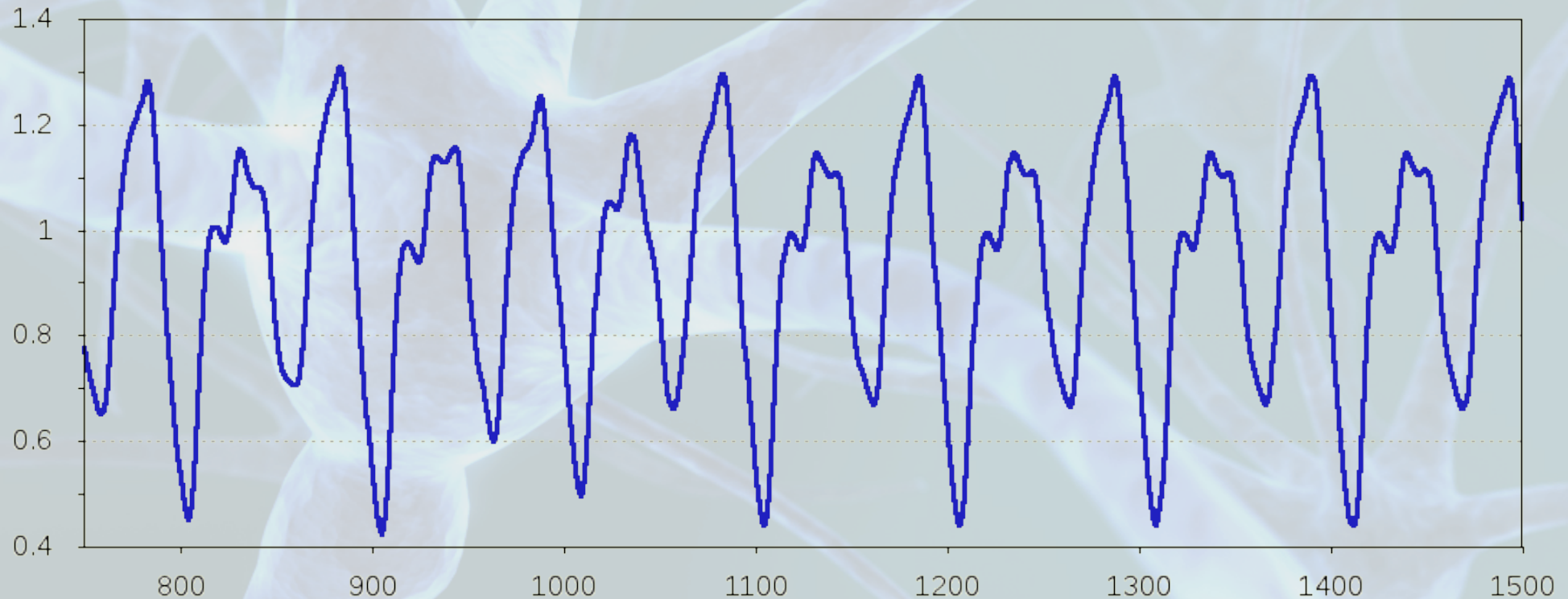
Mackey-Glass differential delay equation:

$$\dot{x}(t) = \frac{0.2 \ x(t-\tau)}{1 + x^{10}(t-\tau)} - 0.1 \ x(t)$$

Parameters:

$$\tau = 17$$

$$x(0) = 1.2$$



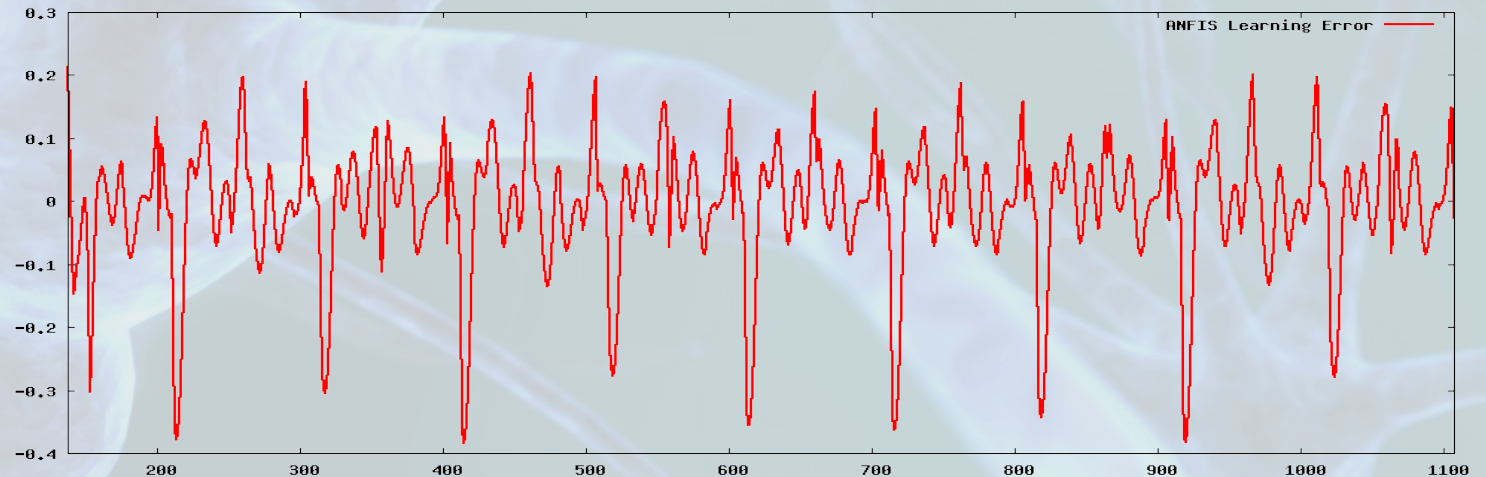
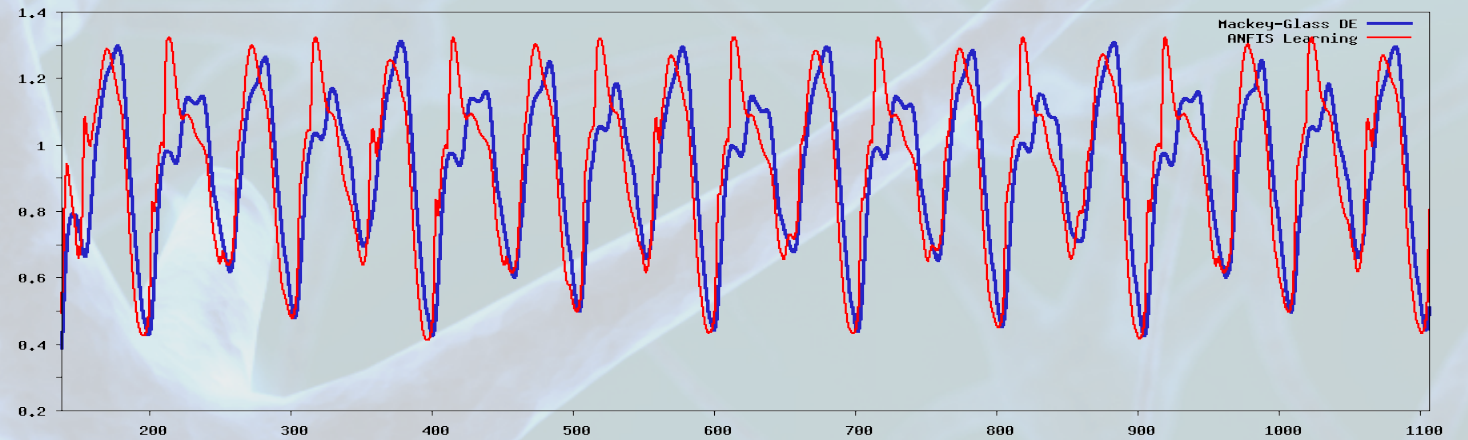
Redes Neuronales: ANFIS

N. Bruno

$T = 2$

$N = 4$

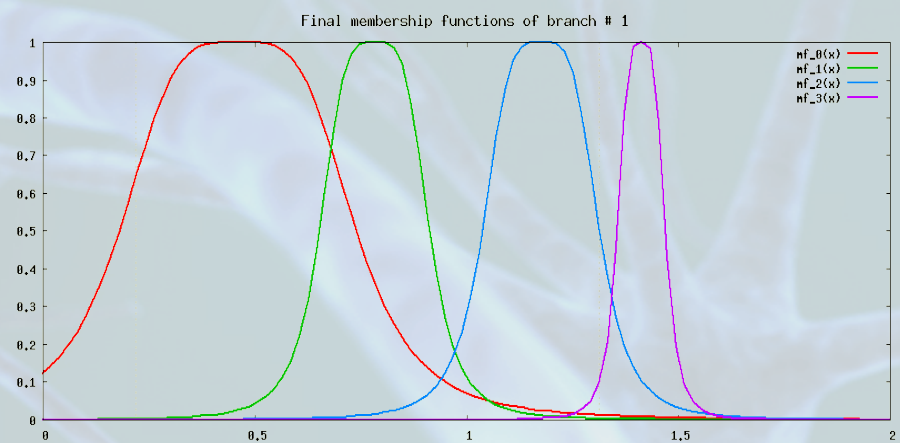
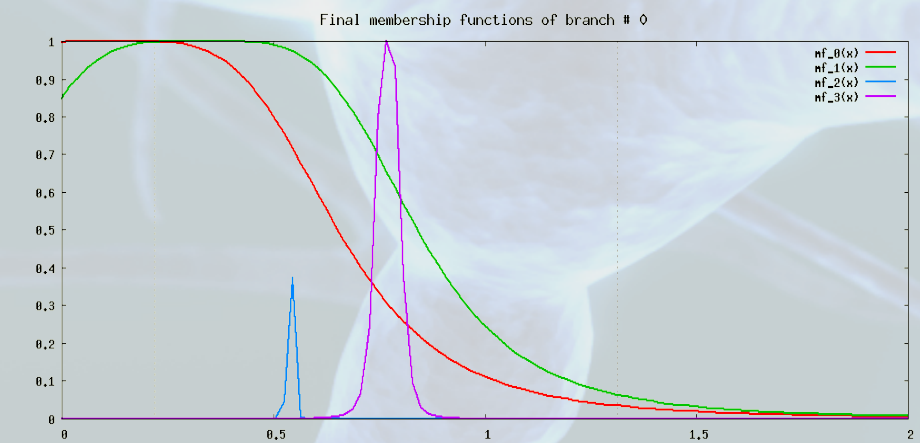
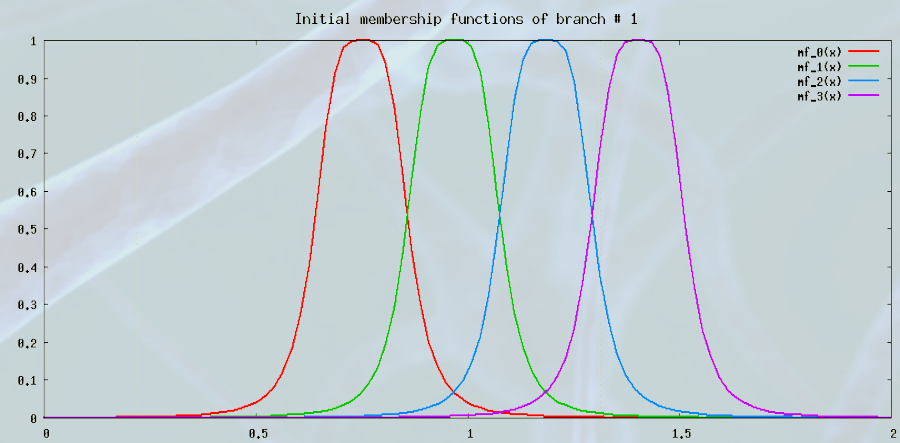
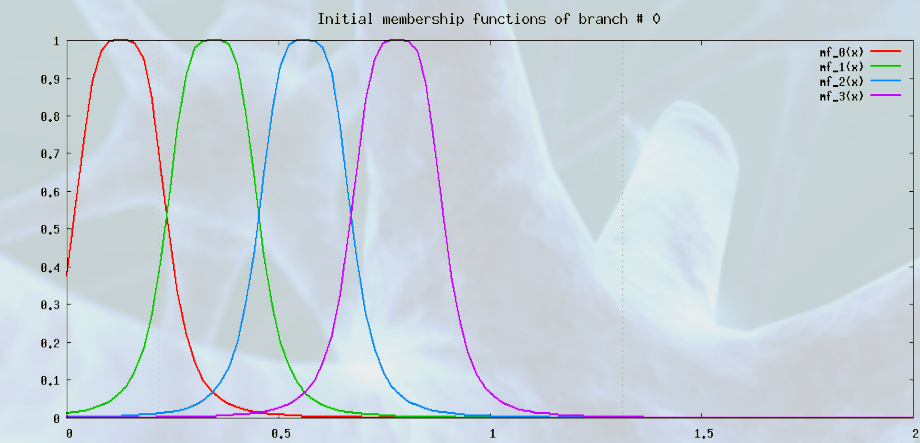
error ~
[-0.4 , 0.2]



Redes Neuronales: ANFIS

N.Bruno

T=2 N=4



Redes Neuronales: ANFIS

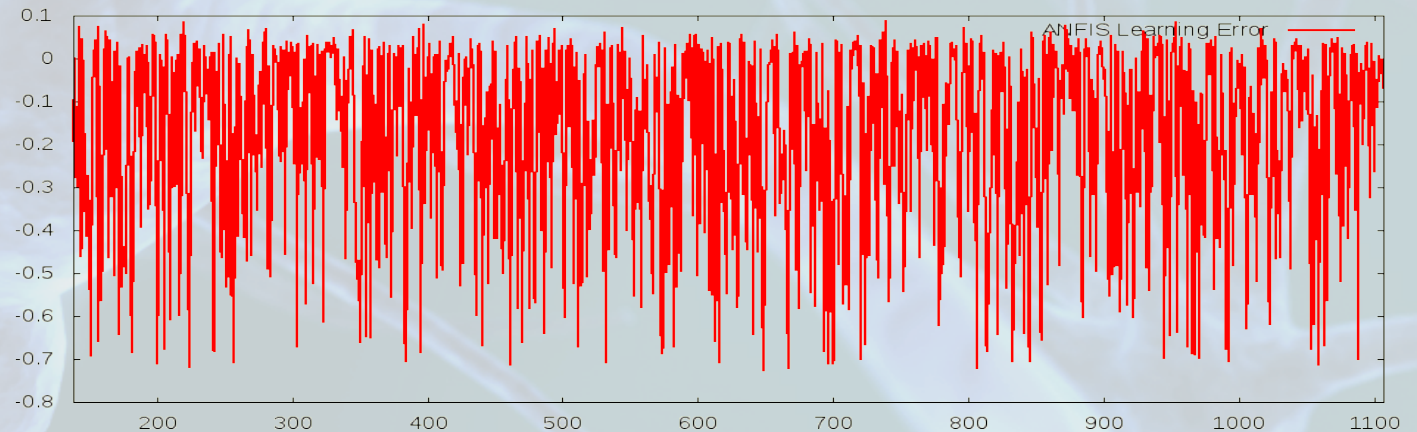
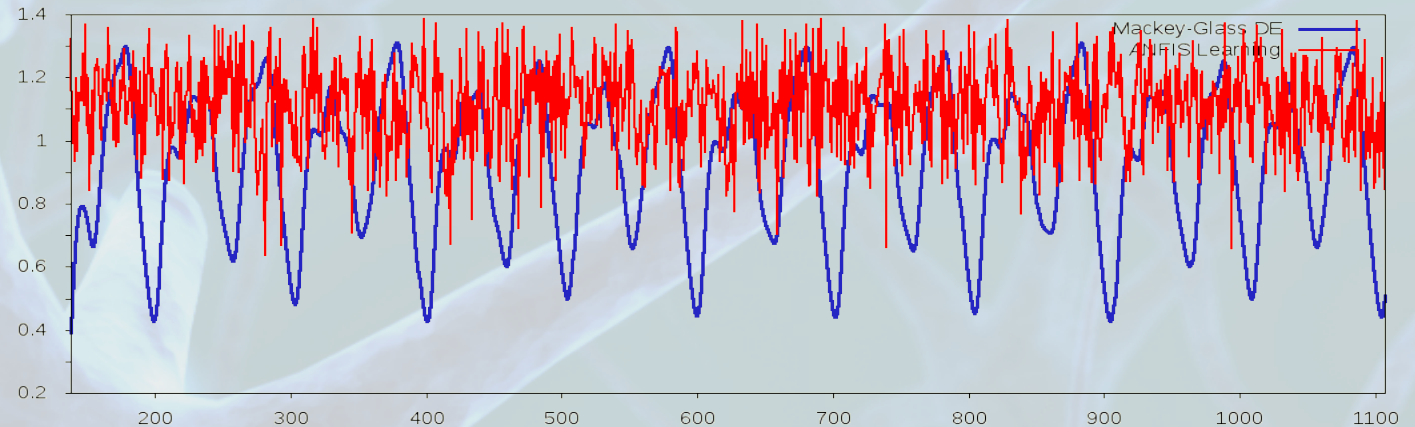
N. Bruno

$T = 2$

$N = 4$

random

error ~
horrible

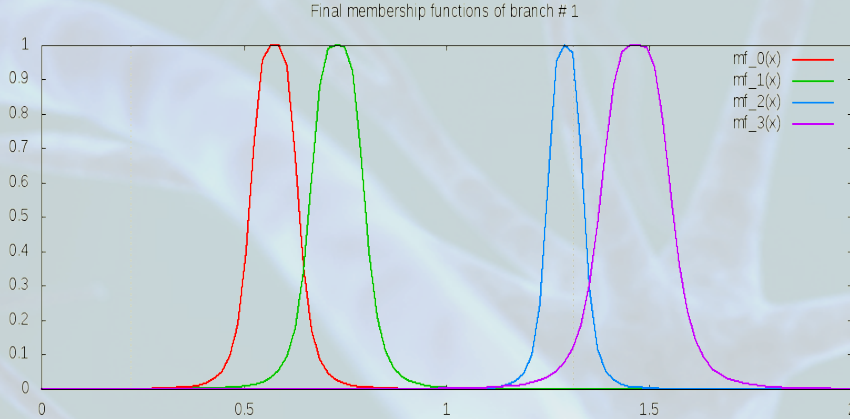
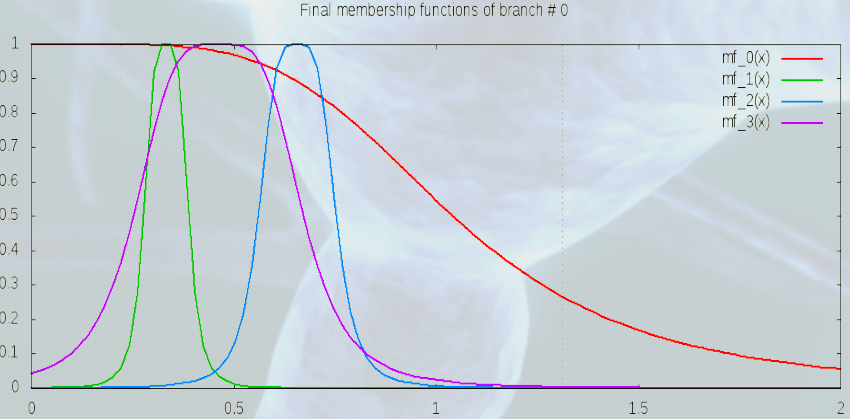
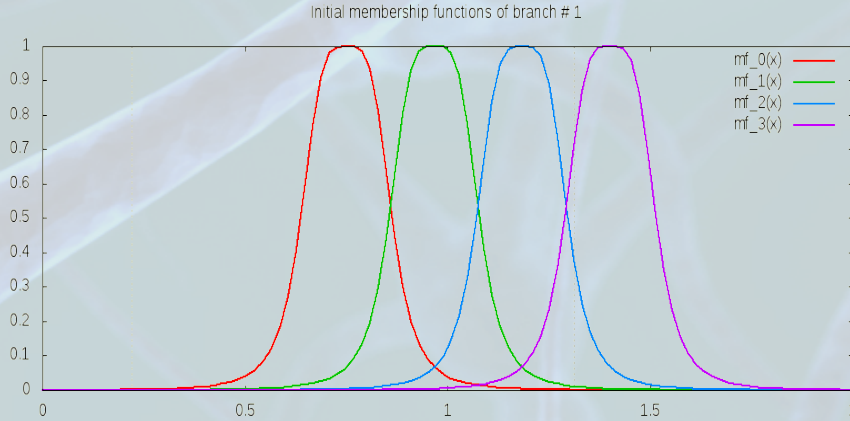
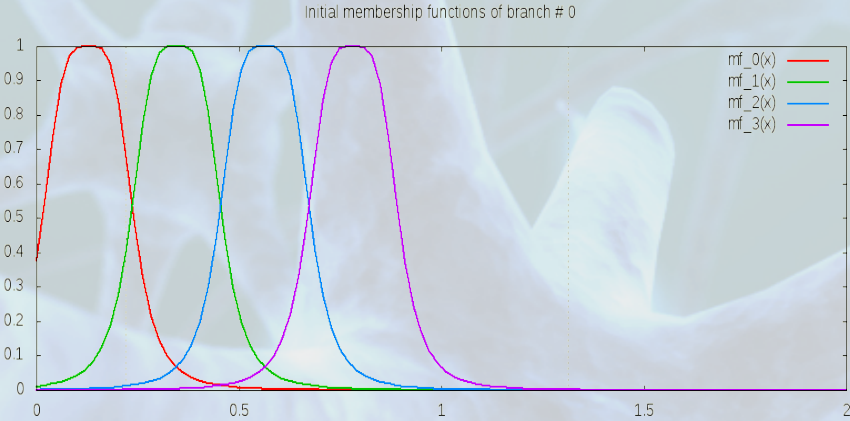


Redes Neuronales: ANFIS

N.Bruno

random

T=2 N=4



Redes Neuronales: ANFIS

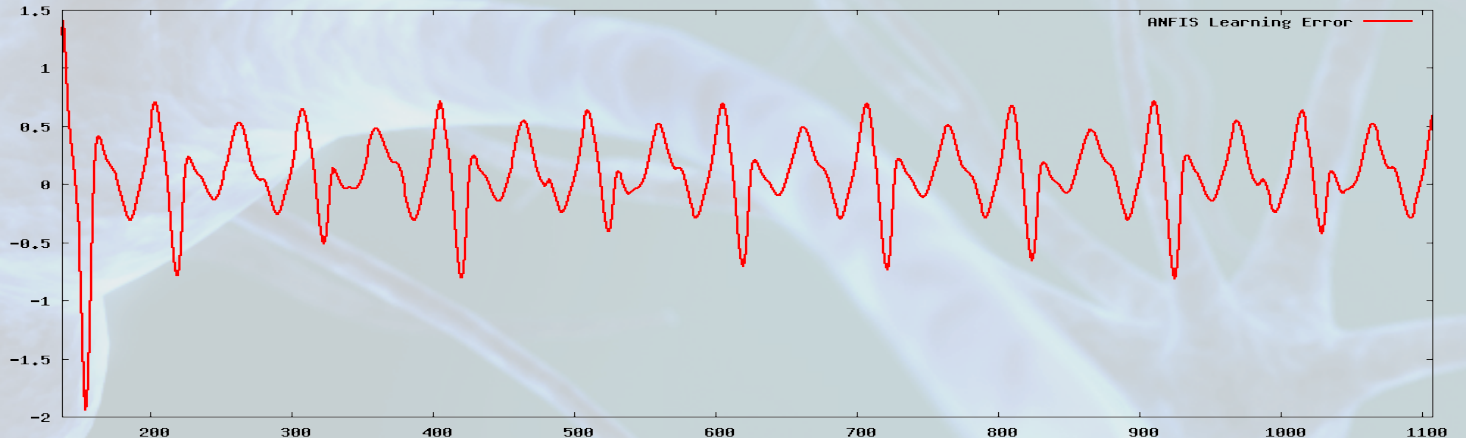
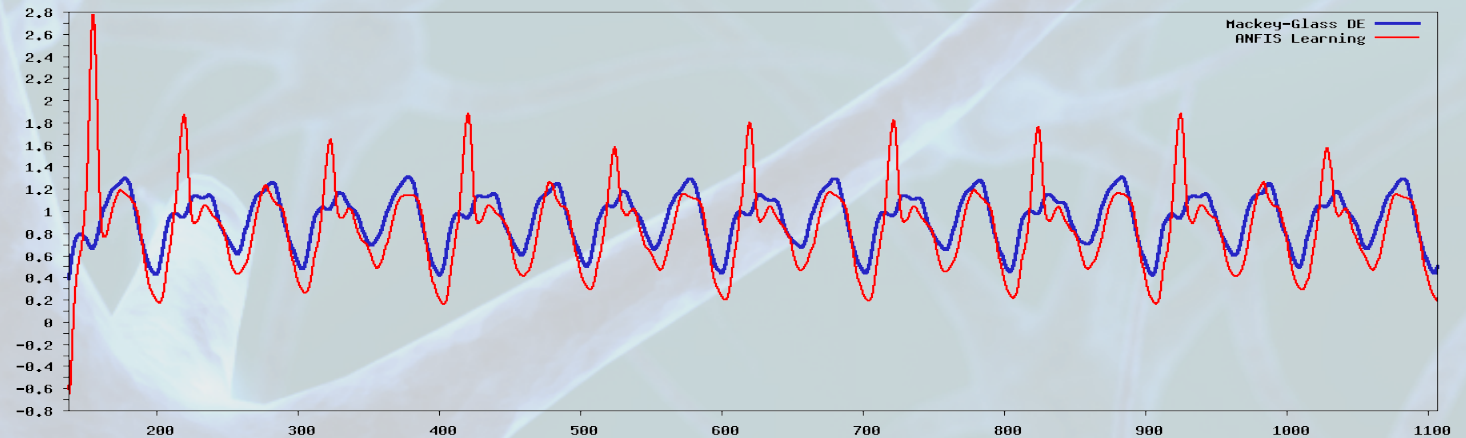
R.Jang

$T = 2$

$N = 4$

error ~

$[-0.8, 0.7]$

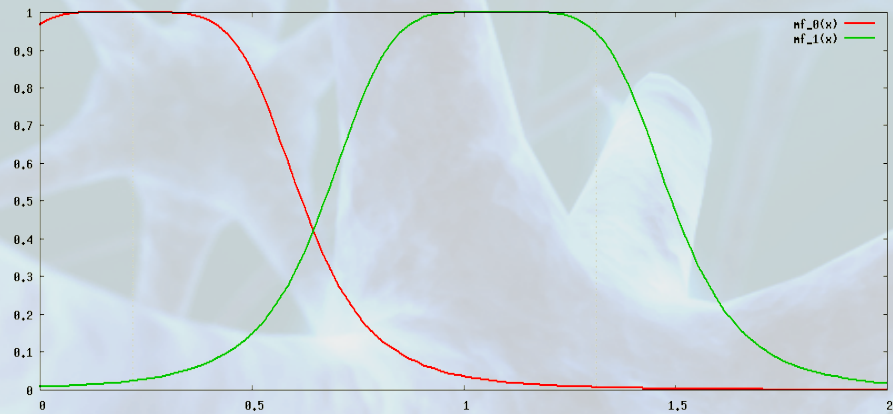


Redes Neuronales: ANFIS

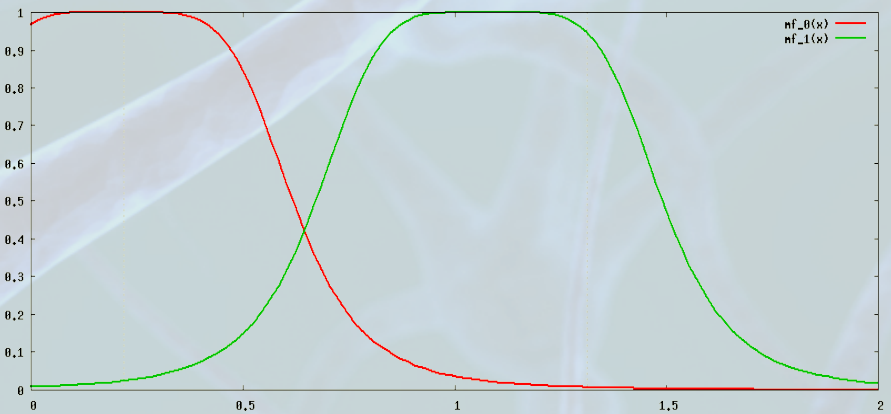
R.Jang

T=2 N=4

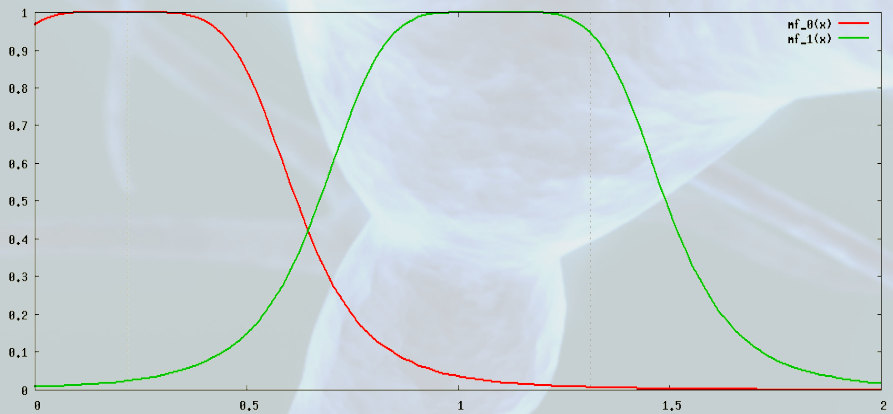
Initial membership functions for input # 0



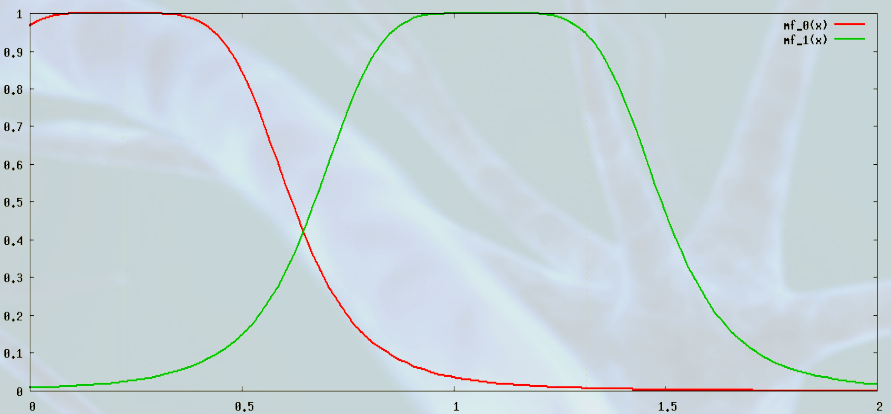
Initial membership functions for input # 1



Initial membership functions for input # 2



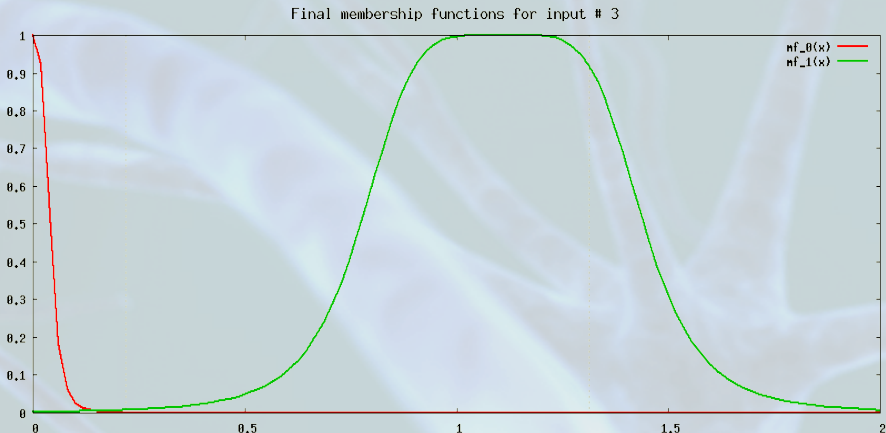
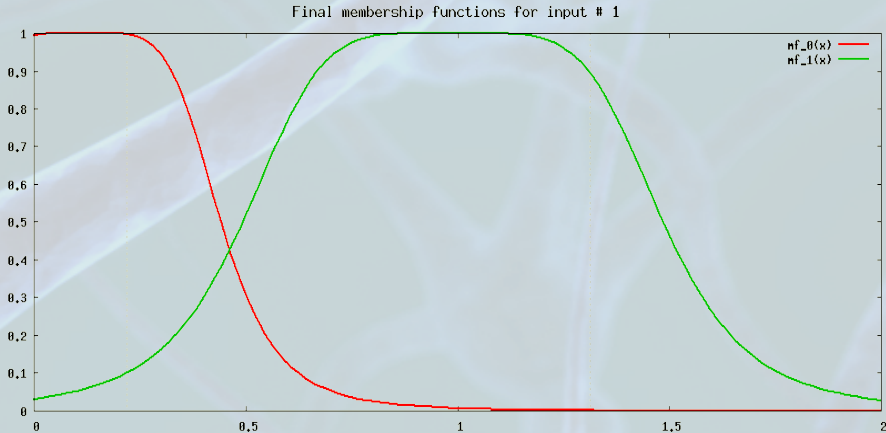
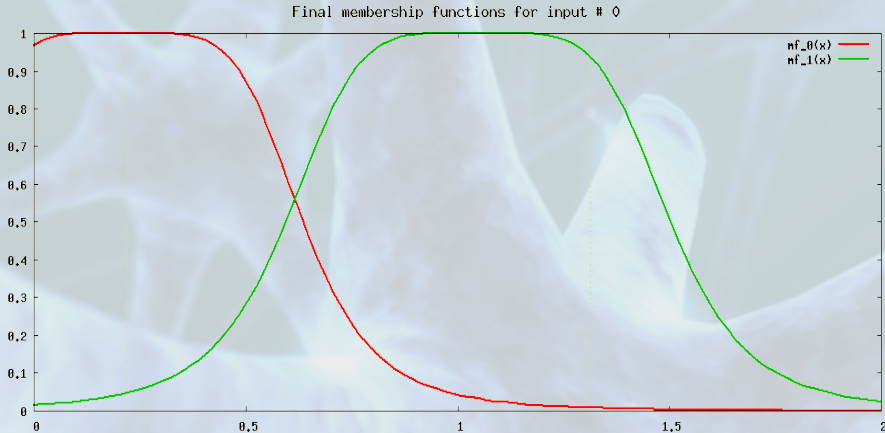
Initial membership functions for input # 3



Redes Neuronales: ANFIS

R.Jang

T=2 N=4



Redes Neuronales: ANFIS

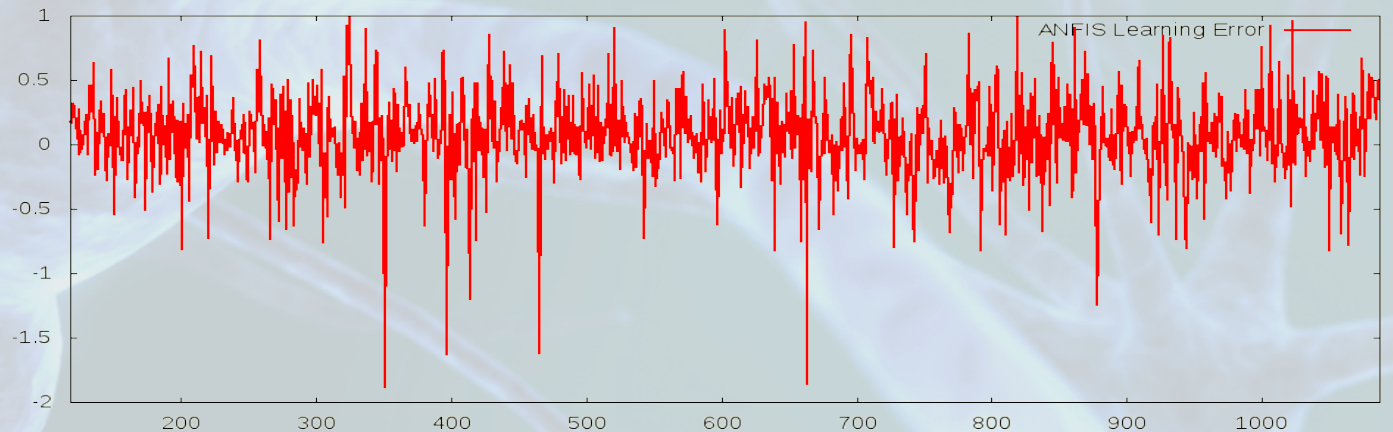
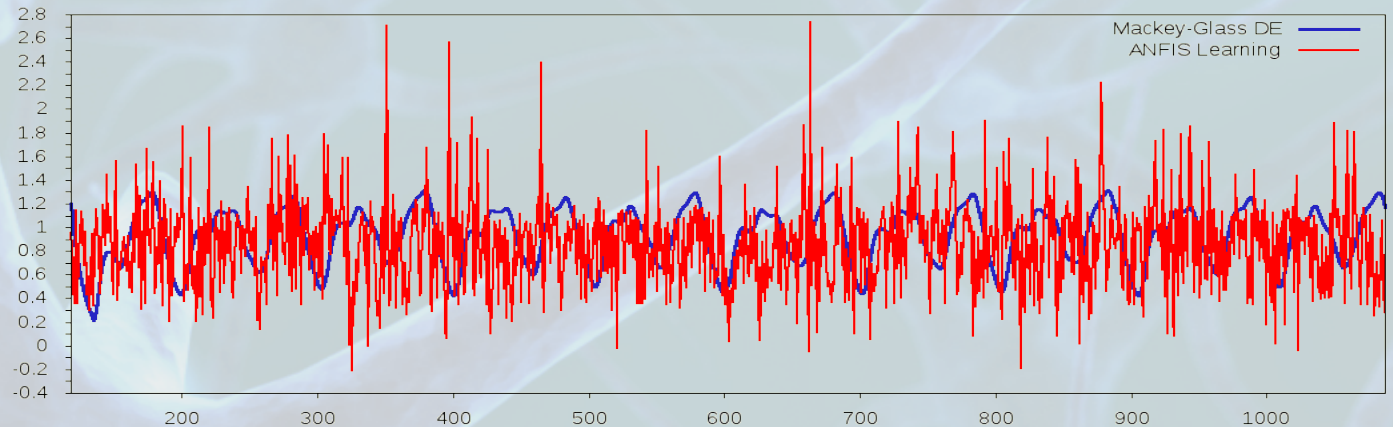
R.Jang

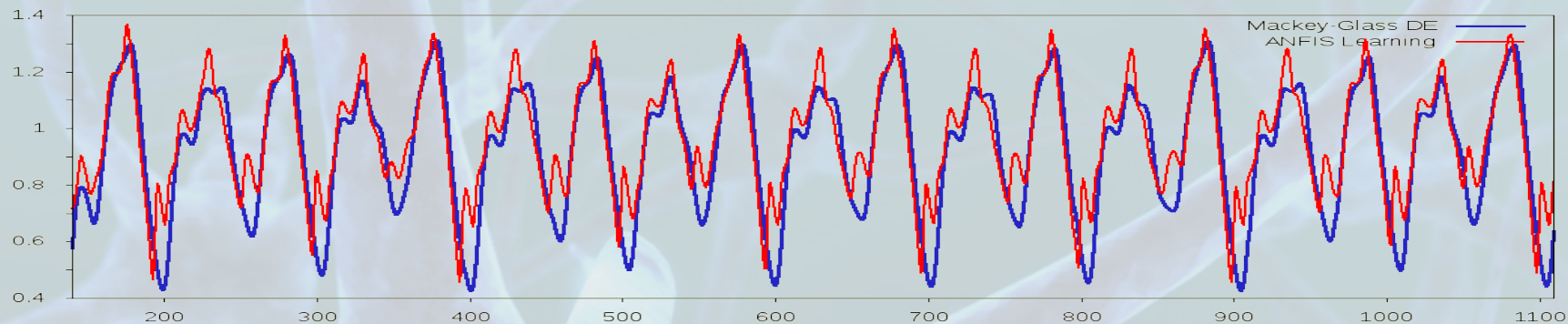
$T = 2$

$N = 4$

random

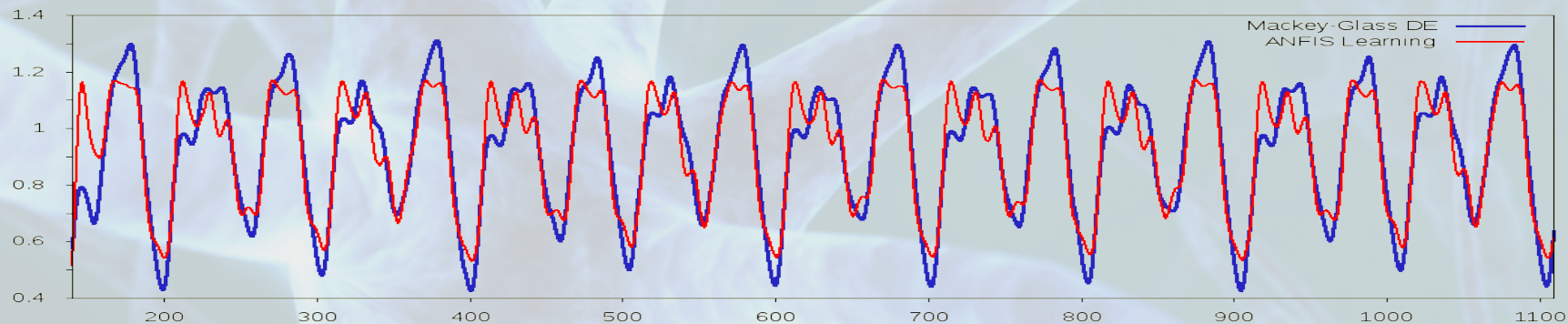
error ~
horrible





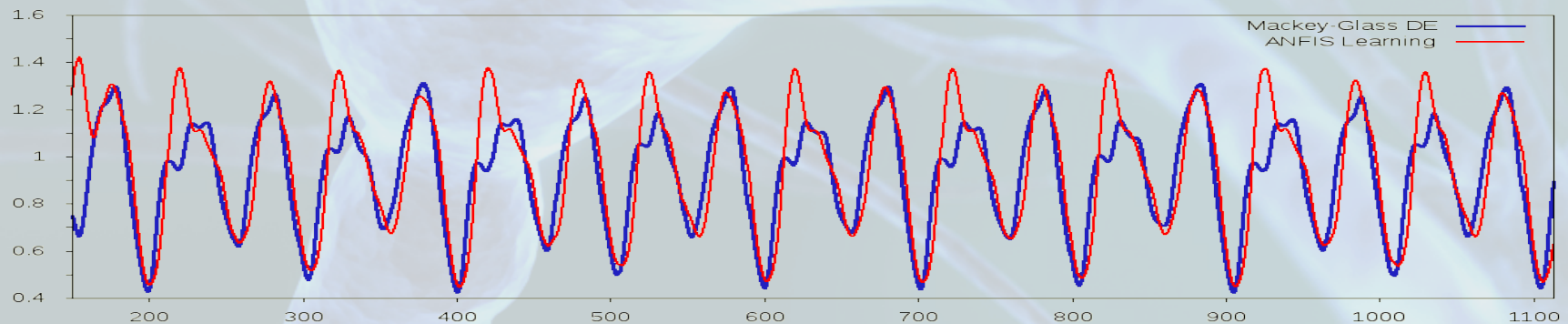
$T = 3$

$N = 4$



$T = 1$

$N = 4$

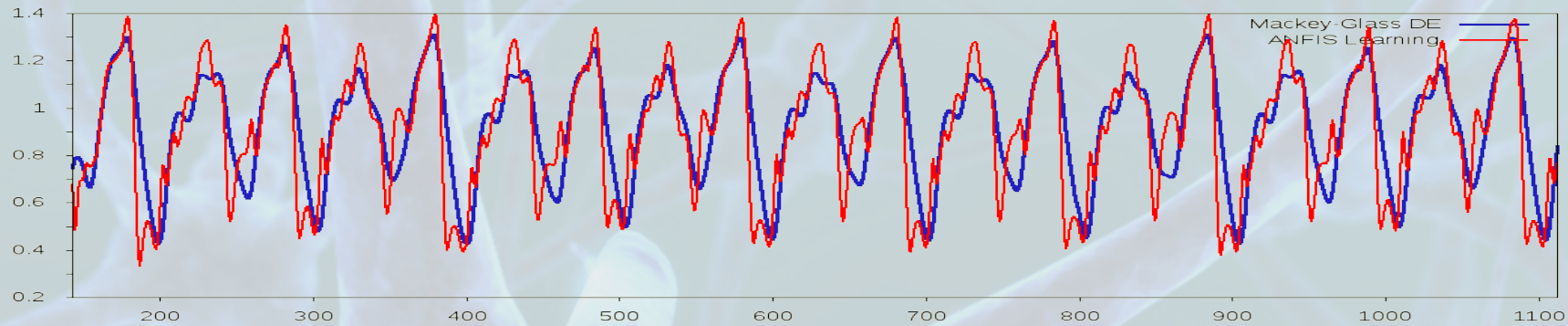


$T = 2$

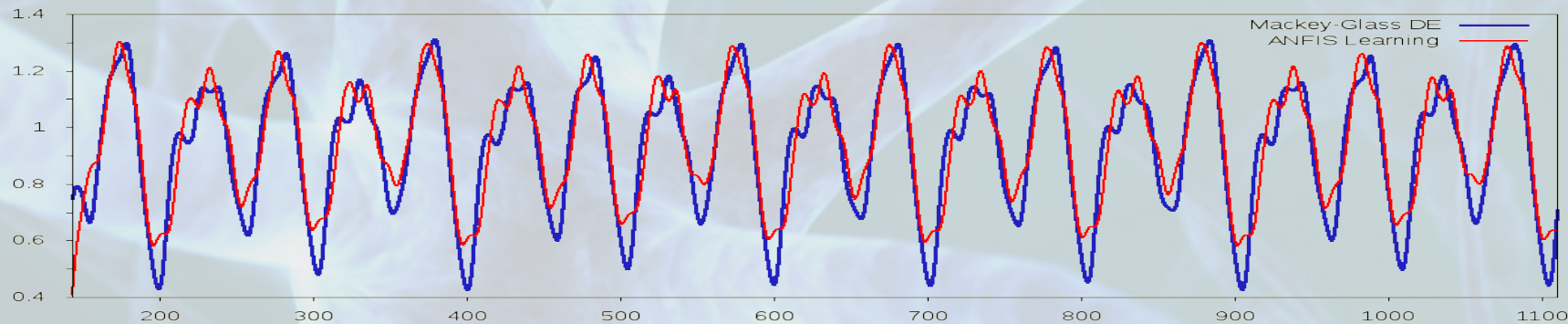
$N = 5$

Redes Neuronales: ANFIS

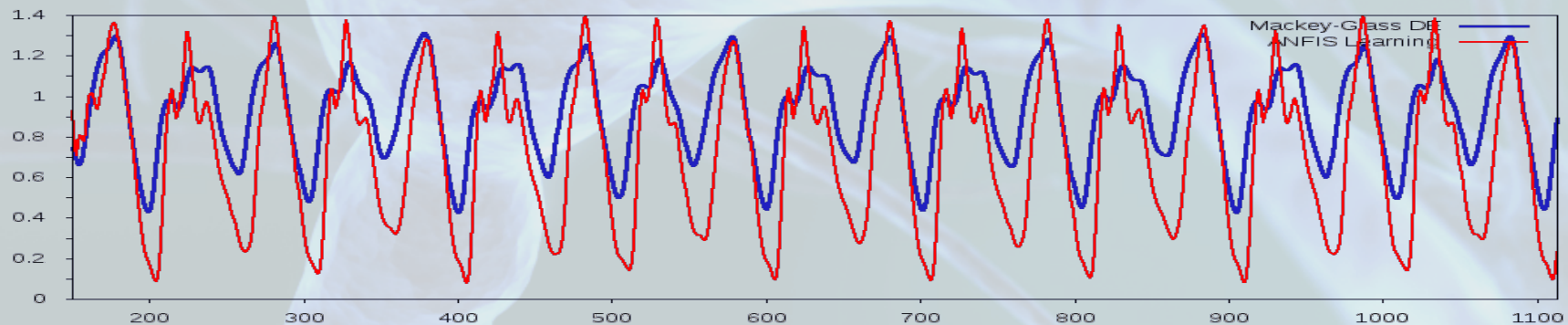
R.Jang



$T = 3$
 $N = 4$



$T = 1$
 $N = 4$



$T = 2$
 $N = 5$

Bibliografía:

- ▶ J.R. Jang ; *ANFIS: Adaptive-Network-Based Fuzzy Inference System* ; IEEE Trans. on Systems, Man & Cybernetics ; Vol. 23, No 3 ; pp. 666-686 ; 1993
- ▶ N. Bruno ; *Sistemas de inferencia difusos basados en redes neuroadaptativas* ; Universidad de Murcia, Facultad de Informática ; 1999
- ▶ J. Hertz et al. ; *Introduction to the theory of neural computation* ; Santa Fe institute ; Perseus Books Publishing ; pp. 90-156 ; 1991