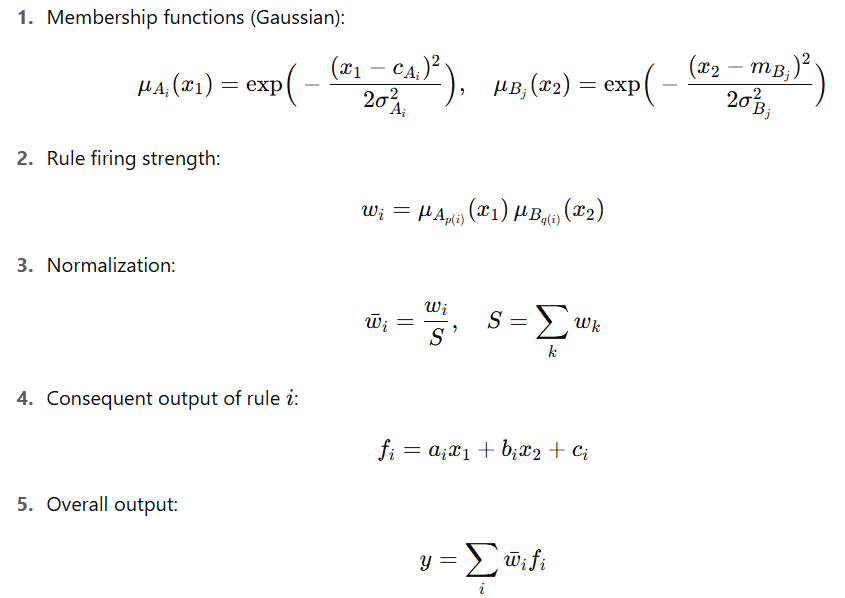
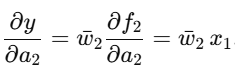
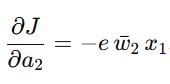
**به نام خدا**

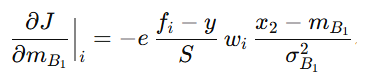
**محمد ابراهیم نوازی 9931323**

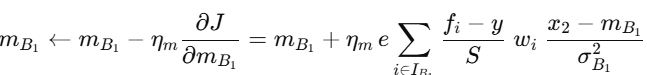
**بخش تحویلی پایانترم هوش مصنوعی مقدماتی**

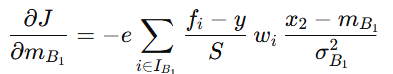
سوال هماهنگ شده:

گرادین نزولی برای a2 :



گرادین نزولی برای mB1  :





حل پایتون برای این سوال:

import numpy as np

# Gaussian membership function

def gaussian(x, c, sigma):

return np.exp(-((x - c) \*\* 2) / (2 \* sigma \*\* 2))

# Forward pass through ANFIS

def anfis\_forward(x1, x2, params):

# Memberships

mu\_A = [gaussian(x1, params["c\_A1"], params["sigma\_A1"]),

gaussian(x1, params["c\_A2"], params["sigma\_A2"])]

mu\_B = [gaussian(x2, params["m\_B1"], params["sigma\_B1"]),

gaussian(x2, params["m\_B2"], params["sigma\_B2"])]

# Rule firing strengths (2x2 = 4 rules)

w = [

mu\_A[0] \* mu\_B[0], # Rule 1: A1 & B1

mu\_A[0] \* mu\_B[1], # Rule 2: A1 & B2

mu\_A[1] \* mu\_B[0], # Rule 3: A2 & B1

mu\_A[1] \* mu\_B[1], # Rule 4: A2 & B2

]

S = sum(w)

w\_bar = [wi / S for wi in w]

# Consequents

f = [

params["a1"] \* x1 + params["b1"] \* x2 + params["c1"],

params["a2"] \* x1 + params["b2"] \* x2 + params["c2"],

params["a3"] \* x1 + params["b3"] \* x2 + params["c3"],

params["a4"] \* x1 + params["b4"] \* x2 + params["c4"],

]

# Output

y = sum(w\_bar[i] \* f[i] for i in range(4))

return y, f, w, w\_bar, S

# One gradient descent update for a2 and m\_B1

def update\_params(x1, x2, y\_d, params, eta\_a=0.01, eta\_m=0.01):

y, f, w, w\_bar, S = anfis\_forward(x1, x2, params)

e = y\_d - y

# ---- Gradient for a2 ----

grad\_a2 = -e \* w\_bar[1] \* x1

params["a2"] -= eta\_a \* grad\_a2 # gradient descent update

# ---- Gradient for m\_B1 ----

grad\_mB1 = 0.0

for i in [0, 2]: # rules that use B1

grad\_mB1 += (-e) \* (f[i] - y) / S \* w[i] \* (x2 - params["m\_B1"]) / (params["sigma\_B1"] \*\* 2)

params["m\_B1"] -= eta\_m \* grad\_mB1

return params, y, e

# Example usage

params = {

"c\_A1": 0.0, "sigma\_A1": 1.0,

"c\_A2": 1.0, "sigma\_A2": 1.0,

"m\_B1": 0.0, "sigma\_B1": 1.0,

"m\_B2": 1.0, "sigma\_B2": 1.0,

"a1": 0.5, "b1": 0.2, "c1": 0.1,

"a2": -0.3, "b2": 0.4, "c2": 0.0,

"a3": 0.1, "b3": -0.2, "c3": 0.3,

"a4": 0.7, "b4": 0.5, "c4": -0.1,

}

# One training sample

x1, x2, y\_d = 0.8, 0.5, 1.2

updated\_params, y\_pred, error = update\_params(x1, x2, y\_d, params)

print("Updated a2:", updated\_params["a2"])

print("Updated m\_B1:", updated\_params["m\_B1"])

print("Prediction:", y\_pred, "Error:", error)

سوال امتحان پایانی در سایت :

