Parametri Iniziali

```
Input: x = [x1, x2, x3, x4] = [10, 30, 30, 50]


Hidden layer weights:
w1=0.1, w2=0.2, w3=0.1, w4=0.3 (per z1)
w5=0.2, w6=0.1, w7=0.2, w8=0.2 (per z2)


Hidden layer biases:
b1=0.1, b2=0.2


Output layer weights:
w9=0.3, w10=0.2


Output bias:
b3=0.1


Target:
y_target = 1


Learning rate:
η = 0.01
```

1 Forward Pass

```
z1 = w1*x1 + w2*x2 + w3*x3 + w4*x4 + b1 = 25.1
z2 = w5*x1 + w6*x2 + w7*x3 + w8*x4 + b2 = 21.2


a1 = ReLU(z1) = 25.1
a2 = ReLU(z2) = 21.2


Output:
output = w9*a1 + w10*a2 + b3 = 11.87
```

2 Calcolo Errore

```
E = 1/2 * (output - y_target)^2
E = 1/2 * (11.87 - 1)^2 ≈ 59.285
```

3 Retropropagation - Delta Output

```
δ_output = output - y_target = 11.87 - 1 = 10.87
```

4 Aggiornamento Pesi Output

```
w9_new = w9 - η*δ_output*a1 ≈ -2.43
w10_new = w10 - η*δ_output*a2 ≈ -2.10
b3_new = b3 - η*δ_output ≈ -0.0087
```

5 Delta Layer Nascosto

```
δ1 = δ_output * w9 * ReLU'(z1) = 10.87 * 0.3 * 1 ≈ 3.261
δ2 = δ_output * w10 * ReLU'(z2) = 10.87 * 0.2 * 1 ≈ 2.174
```

6 Aggiornamento Pesi Layer Nascosto

```
Per z1:
w1_new = 0.1 - 0.01*3.261*10 ≈ -0.2261
w2_new = 0.2 - 0.01*3.261*30 ≈ -0.7783
w3_new = 0.1 - 0.01*3.261*30 ≈ -0.8783
w4_new = 0.3 - 0.01*3.261*50 ≈ -1.3305
b1_new = 0.1 - 0.01*3.261 ≈ 0.0674


Per z2:
w5_new = 0.2 - 0.01*2.174*10 ≈ -0.0174
w6_new = 0.1 - 0.01*2.174*30 ≈ -0.5522
w7_new = 0.2 - 0.01*2.174*30 ≈ -0.4522
w8_new = 0.2 - 0.01*2.174*50 ≈ -0.887
b2_new = 0.2 - 0.01*2.174 ≈ 0.1783
```

7 Riepilogo Pesi Aggiornati

Peso	Vecchio	Nuovo
w1	0.1	-0.2261
w2	0.2	-0.7783
w3	0.1	-0.8783
w4	0.3	-1.3305
w5	0.2	-0.0174
w6	0.1	-0.5522
w7	0.2	-0.4522
w8	0.2	-0.887
w9	0.3	-2.43
w10	0.2	-2.10
b1	0.1	0.0674
b2	0.2	0.1783
b3	0.1	-0.0087