Τεχνητή Νοημοσύνη και Μηχανική Μάθηση

Κωνσταντίνος Καραμανής

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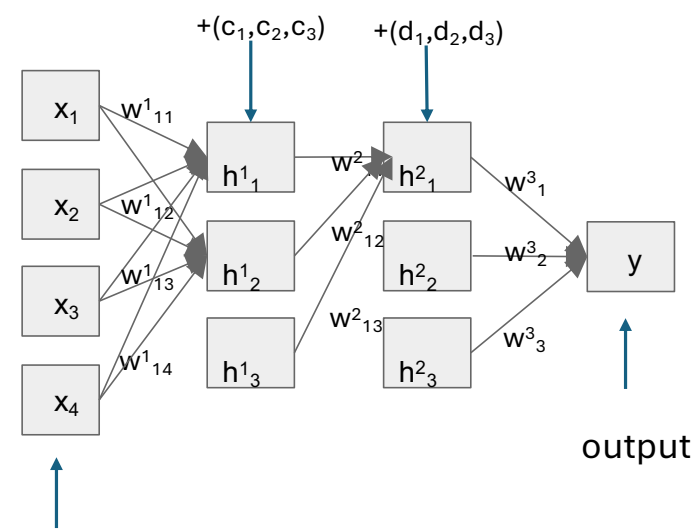
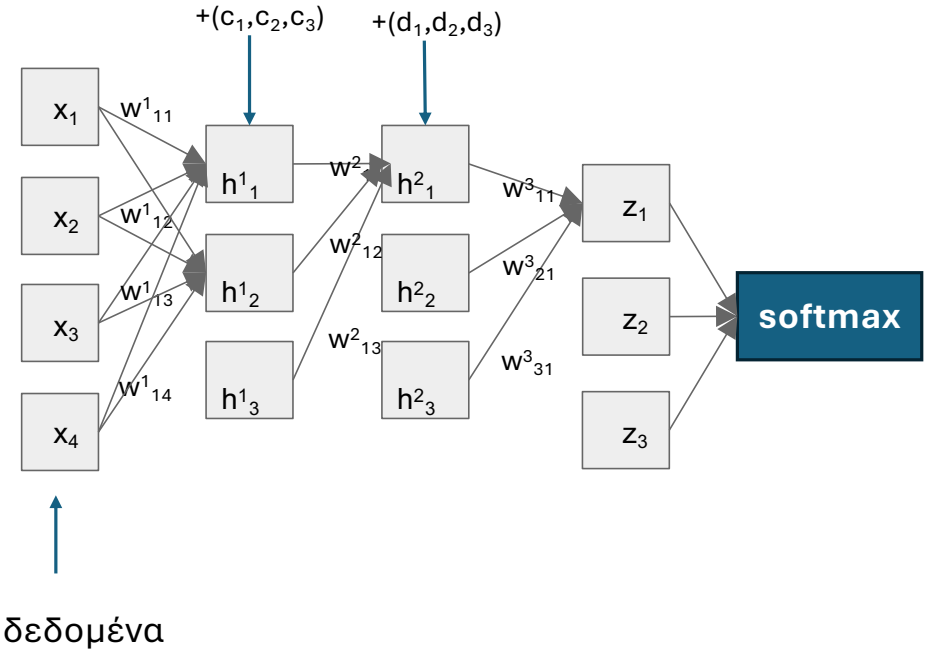
https://caramanis.github.io/

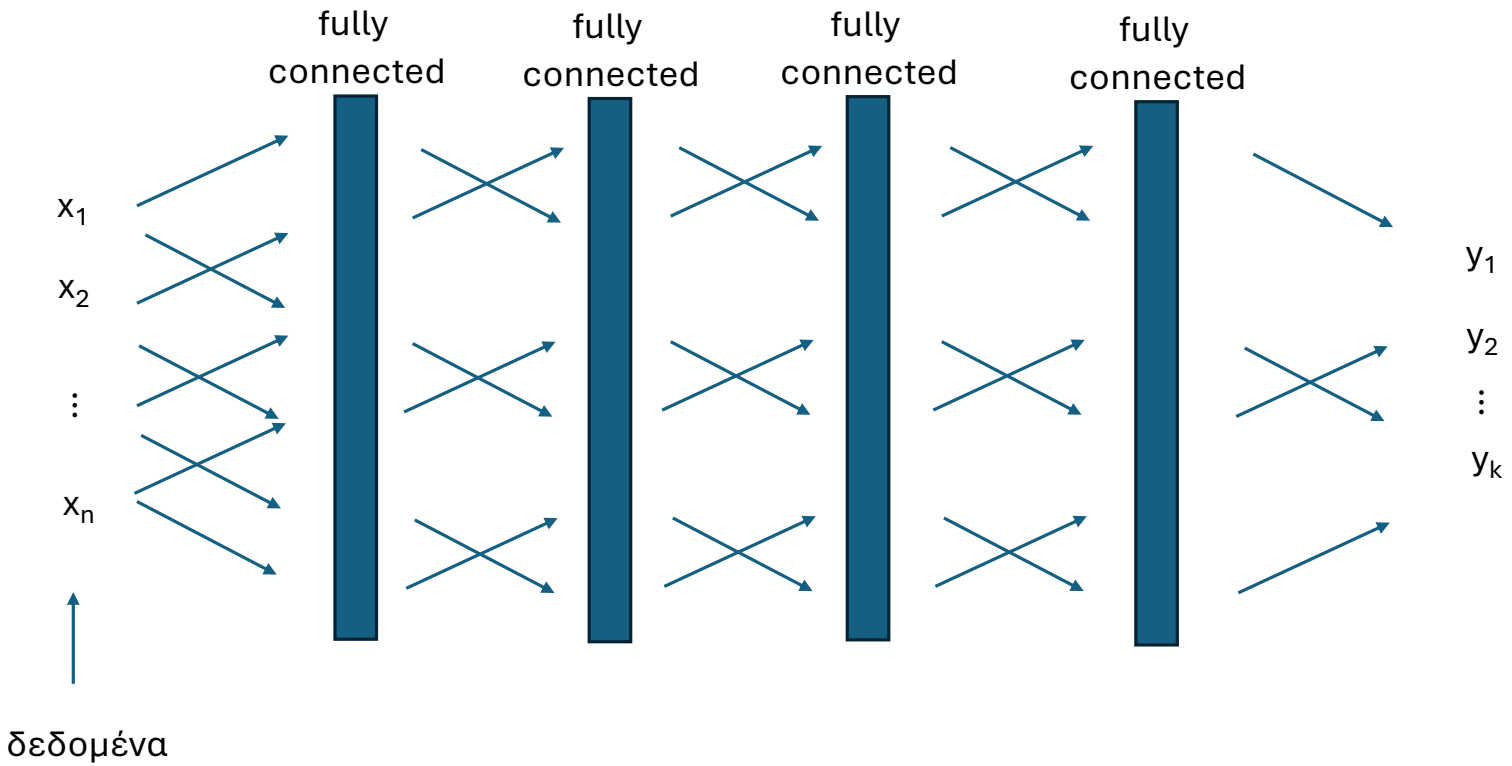
Ας θυμηθούμε τα προηγούμενα...

Fully Connected + Softmax





Fully Connected + ReLU



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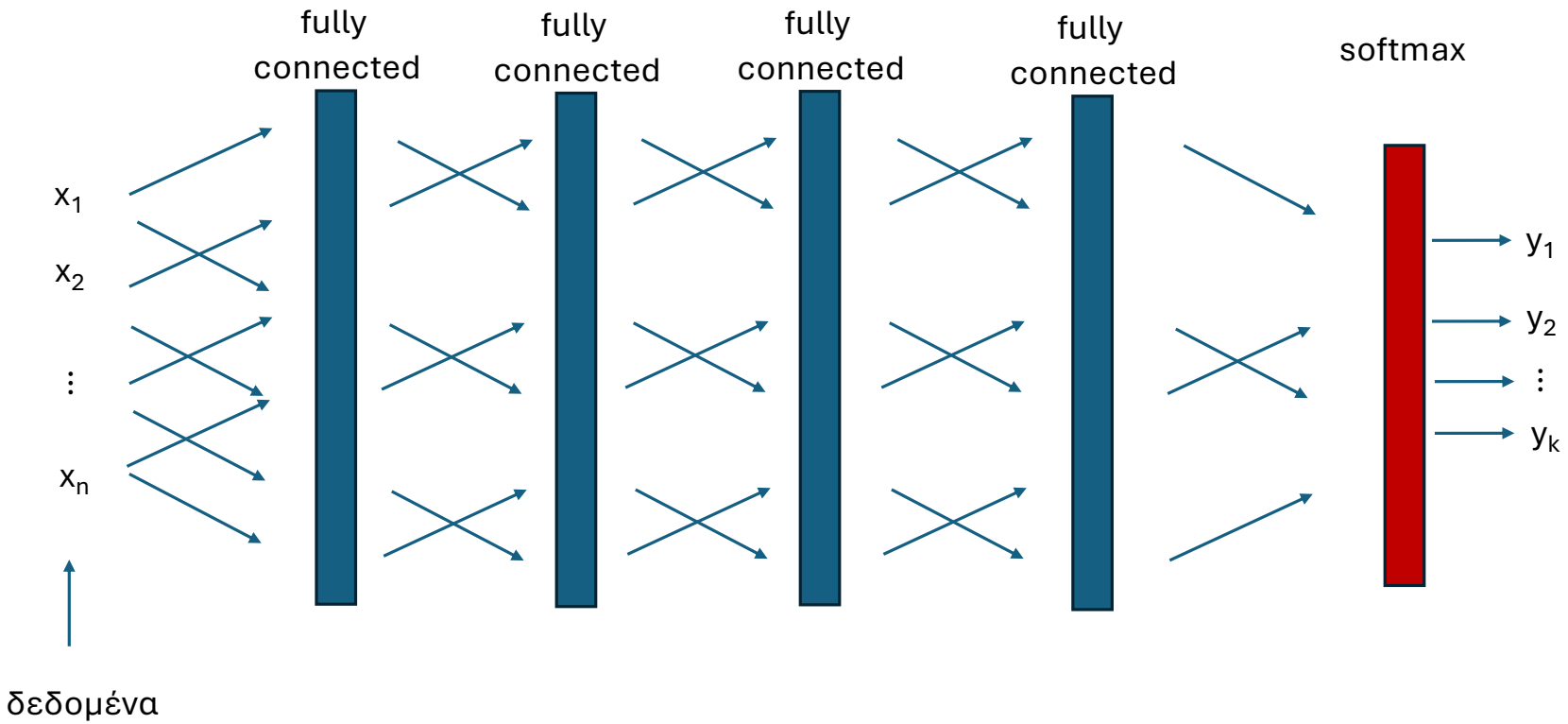
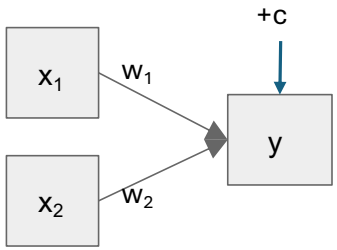
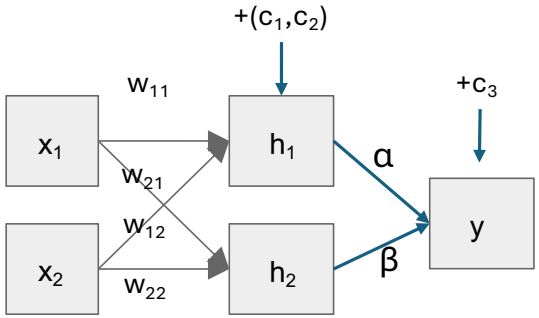


Αρκούν τα Γραμμικά Επίπεδα;





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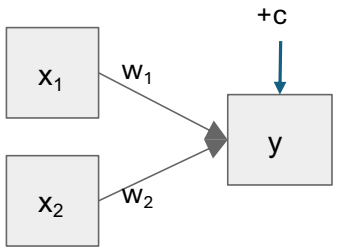
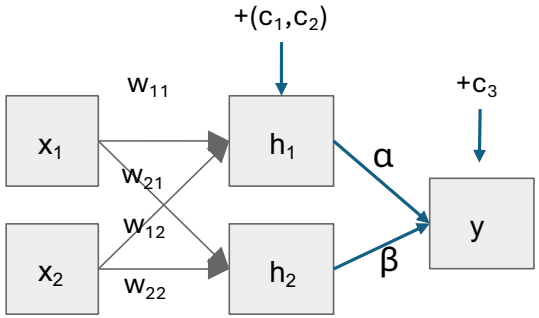
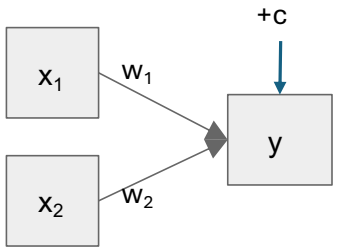
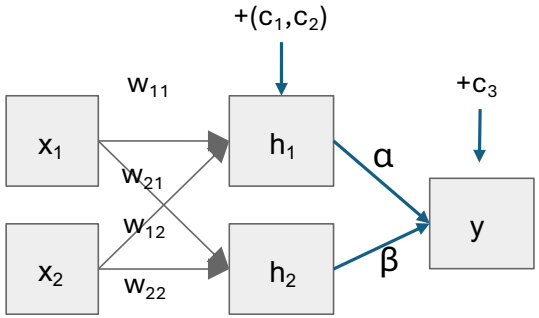




$$y = w_1 x_1 + w_2 x_2 + c$$

Αρκούν τα Γραμμικά Επίπεδα;

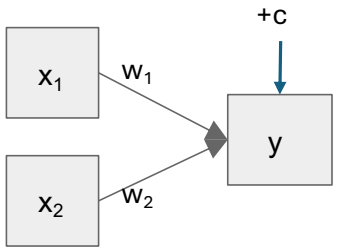


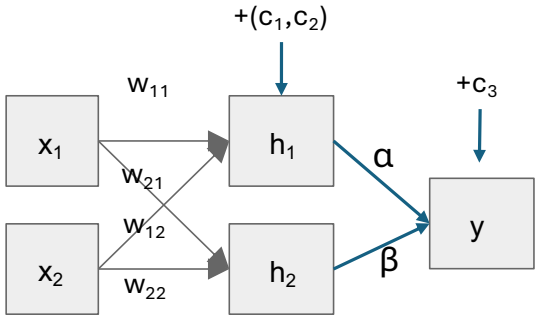


$y = w_1 x_1 + w_2 x_2 + c$

$y = \alpha h_1 + \beta h_2 + c_3$

Αρκούν τα Γραμμικά Επίπεδα;

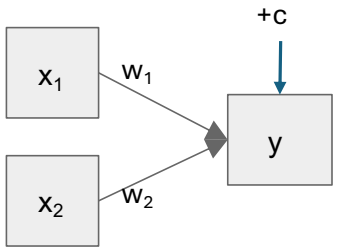


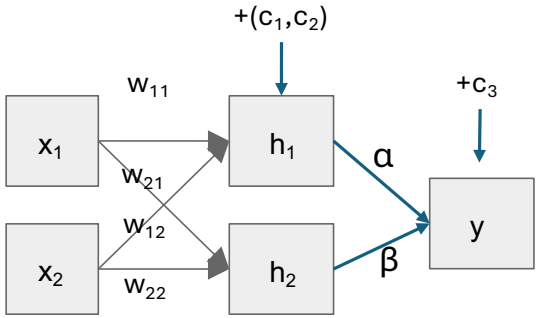


$$y = w_1 x_1 + w_2 x_2 + c$$

$$y = \alpha h_1 + \beta h_2 + c_3 = \alpha(w_{11} x_1 + w_{12} x_2 + c_1) + \beta(w_{21} x_1 + w_{22} x_2 + c_2) + c_3$$

Αρκούν τα Γραμμικά Επίπεδα;





$$y = w_1 x_1 + w_2 x_2 + c$$

$$y = \alpha h_1 + \beta h_2 + c_3 = \alpha(w_{11}x_1 + w_{12}x_2 + c_1) + \beta(w_{21}x_1 + w_{22}x_2 + c_2) + c_3$$

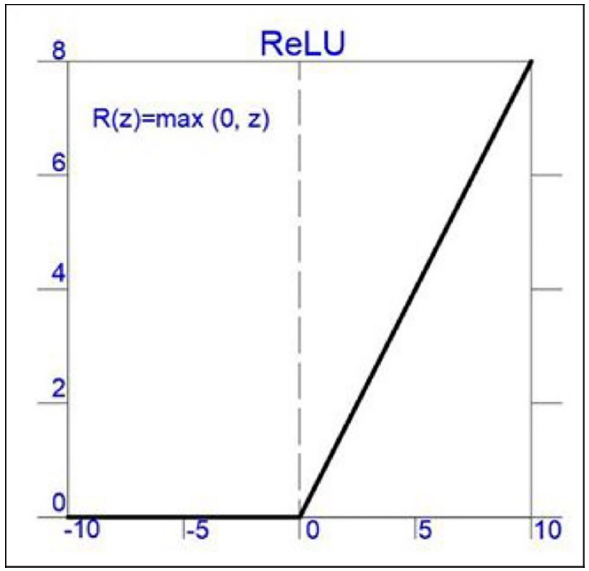
$$= (\alpha w_{11} + \beta w_{21})x_1 + (\alpha w_{12} + \beta w_{22})x_2 + (\alpha c_1 + \beta c_2) + c_3$$

$$= \widetilde{w_1}x_1 + \widetilde{w_2}x_2 + \tilde{c}$$

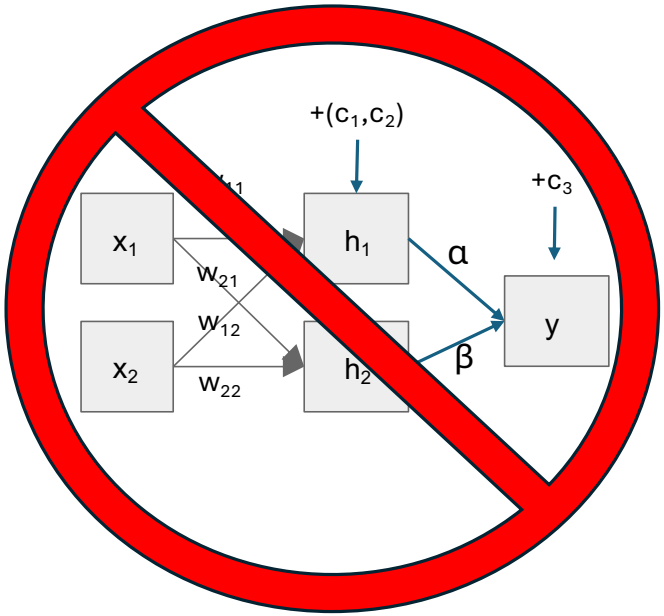
Μη-Γραμμικά Επίπεδα: ReLU

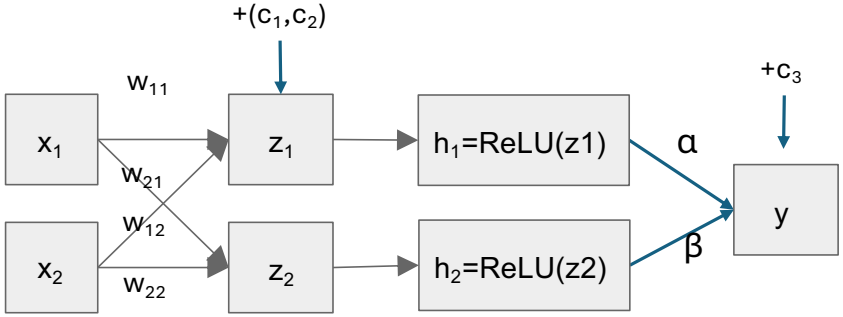
ReLU(α) = max(0,α)

α	ReLU(α)
2	2
-1	0
4	4

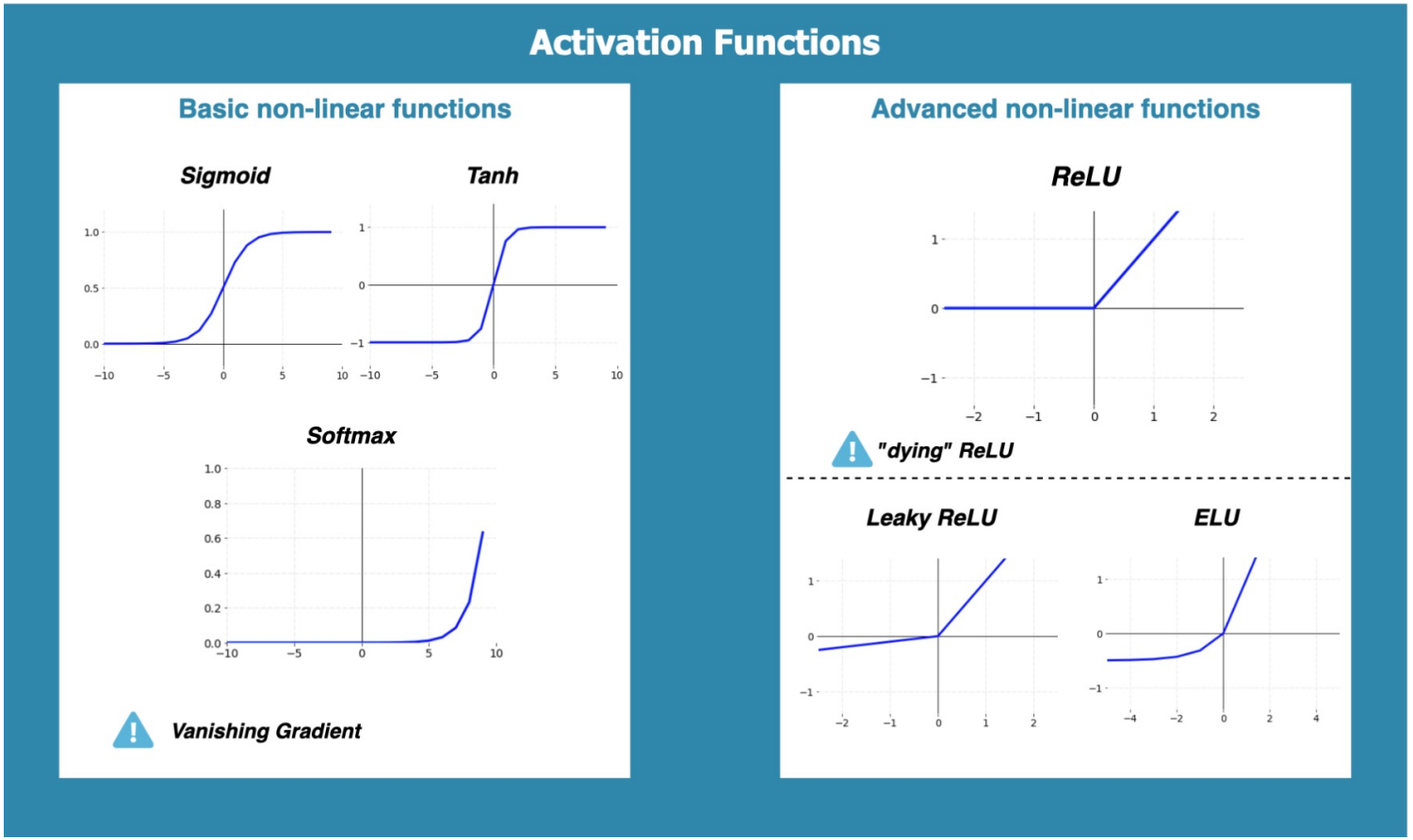


Μη-Γραμμικά Επίπεδα: ReLU

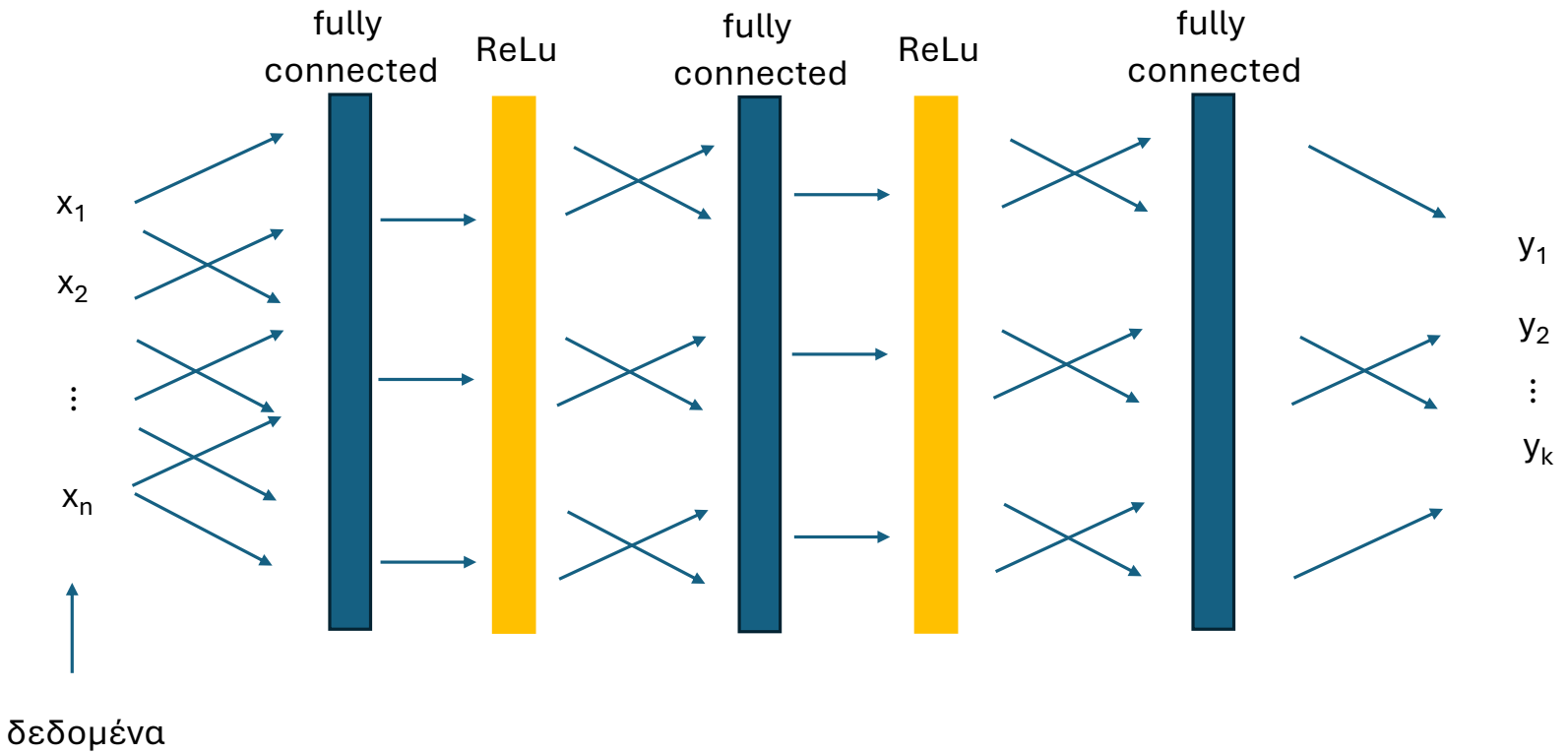




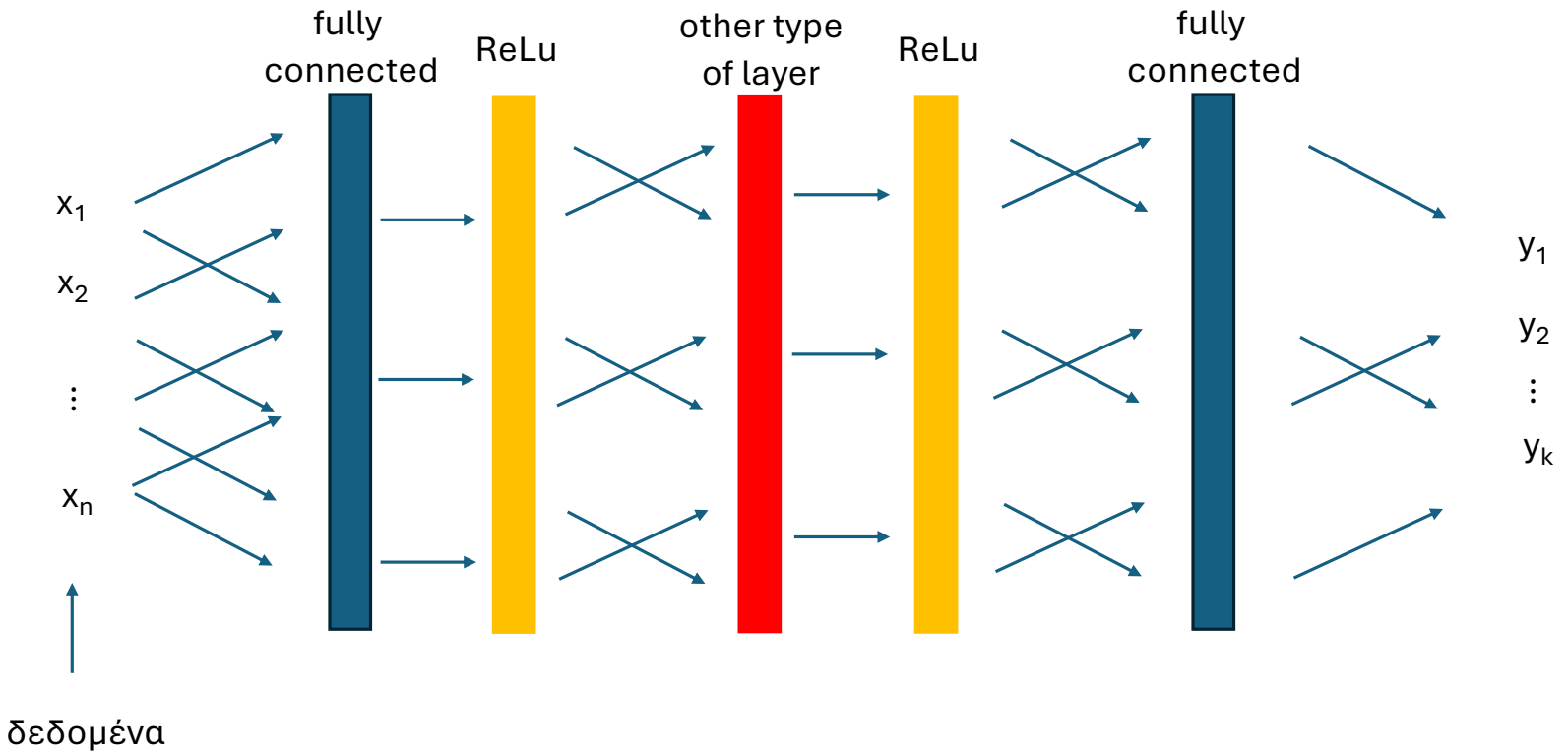
Γιατί ReLU και όχι κάτι άλλο;



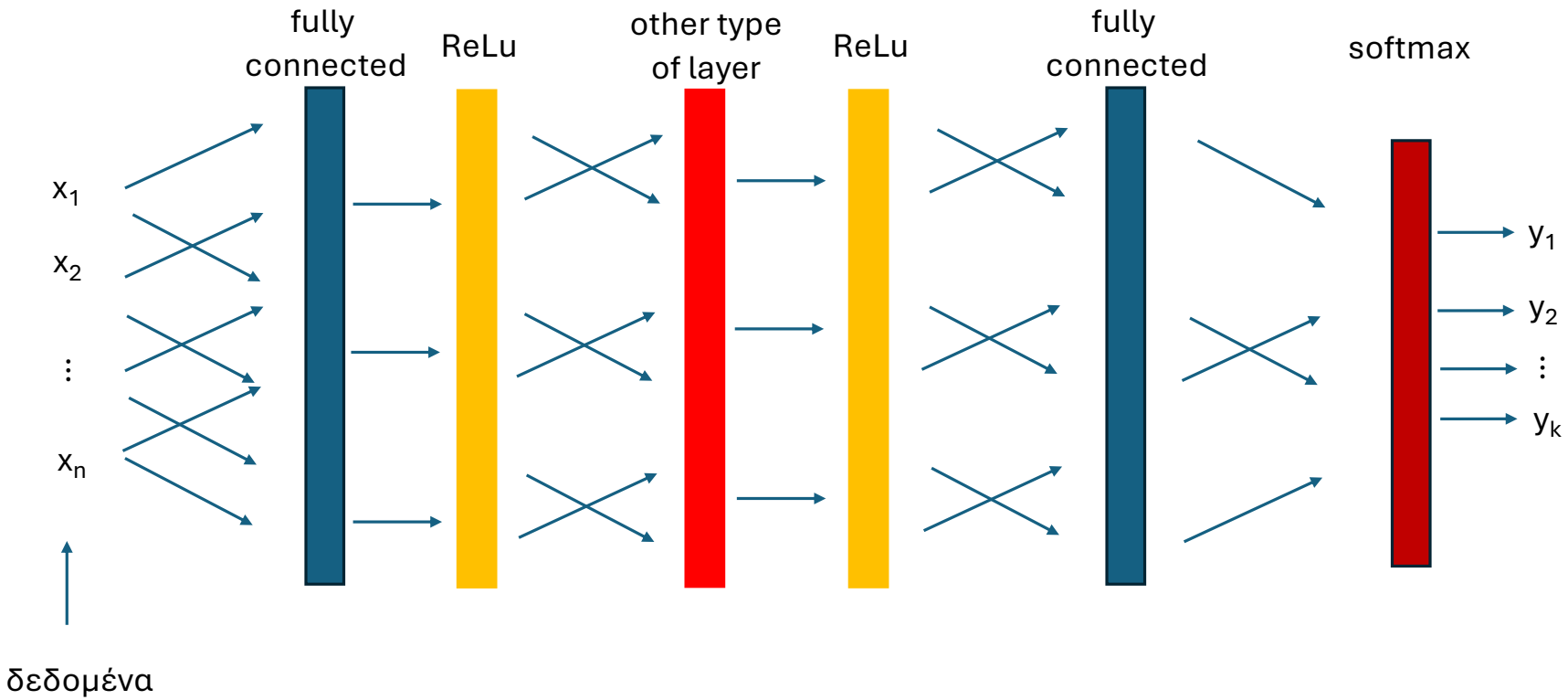
Fully Connected + ReLU



Fully Connected + ReLU + other



Fully Connected + ReLU + SoftMax + other



Πως τα χρησιμοποιούμε

Δέντρα απόφασης

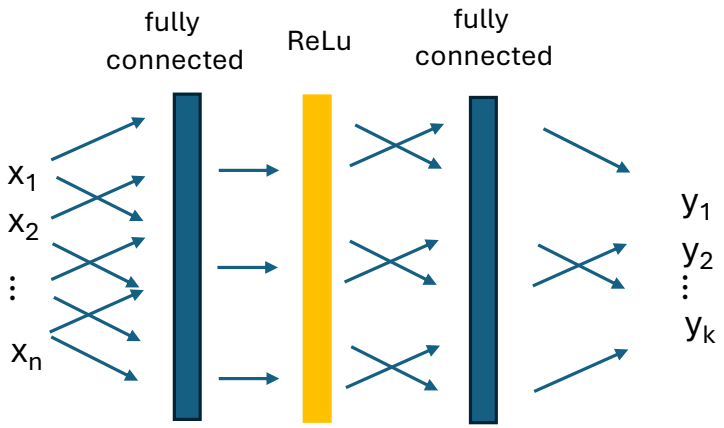
1. mymodel = DecisionTrees(max_depth=3) – ορίζουμε την οικογένεια
2. mymodel.fit(X,y) – βρίσκουμε παραμέτρους που συμφωνούν με (X,y)
3. mymodel.predict(x) – υπολογίζουμε προβλέψεις για τα x

Για νευρωνικά δίκτυα, αυτές οι τρείς ιδέες παραμένουν, αλλά οι εντολές αλλάζουν

model = MyNNet()

Ορίζουμε κάθε επίπεδο:

MyNNet = x→ fc1→ReLU→fc2→y



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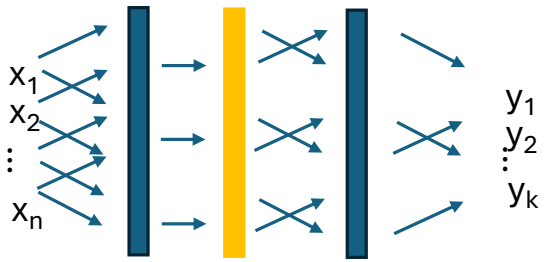

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MyNNet = x→ fc1→ReLU→fc2→y

```python
# Define the neural network
class MyNNet(nn.Module):
    def __init__(self):
        super(MyNNet, self).__init__()
        self.fc1 = nn.Linear(3, 2)  # 3 inputs to 2 outputs
        self.fc2 = nn.Linear(2, 1)  # 2 inputs to 1 output
        self.relu = nn.ReLU()

    def forward(self, x):
        x = self.fc1(x)
        x = self.relu(x)
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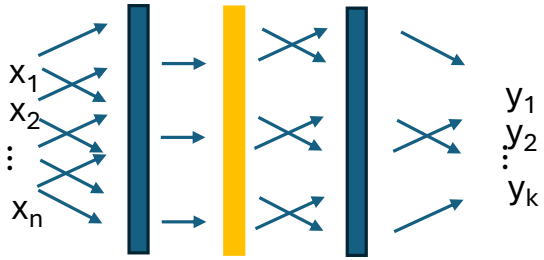


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def __init__(self):
    super(MyNNet, self).__init__()
    self.fc1 = nn.Linear(3, 2)
    self.fc2 = nn.Linear(2, 1)
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```

```
# Define the neural network
class MyNNet(nn.Module):
    def __init__(self):
        super(SimpleNet, self).__init__()
        self.fc1 = nn.Linear(3, 2)  # 3 inputs to 2 outputs
        self.fc2 = nn.Linear(2, 1)  # 2 inputs to 1 output
        self.relu = nn.ReLU()

    def forward(self, x):
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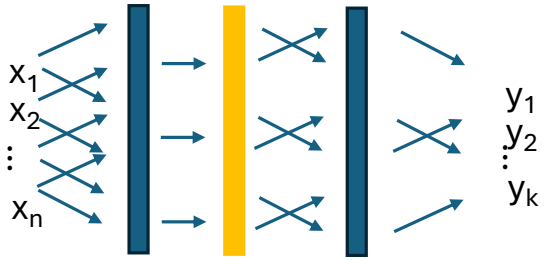


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self.fc1

self.relu

self.fc2

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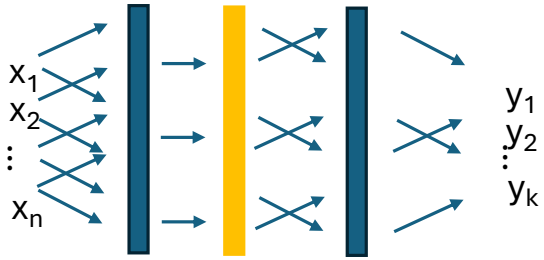


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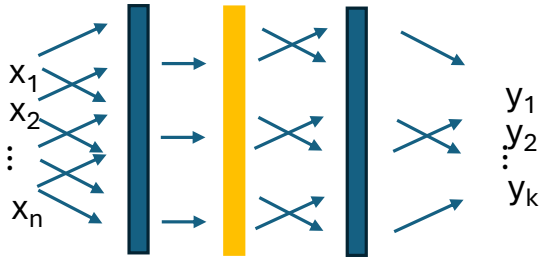


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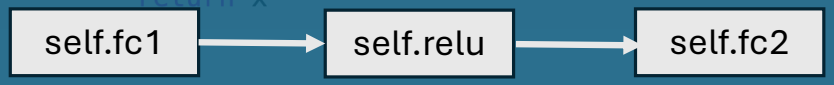

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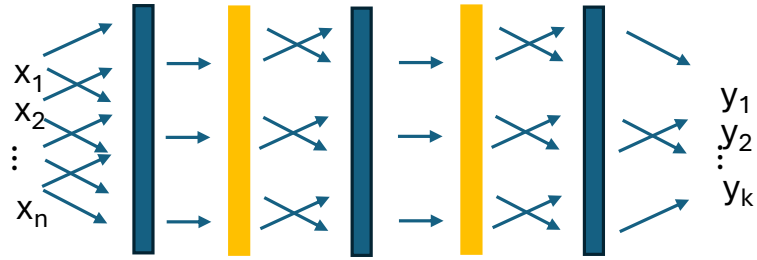

Ορίζουμε κάθε επίπεδο:

BigNNet = x→ fc1→ReLU→fc2

ReLU → fc3 →y

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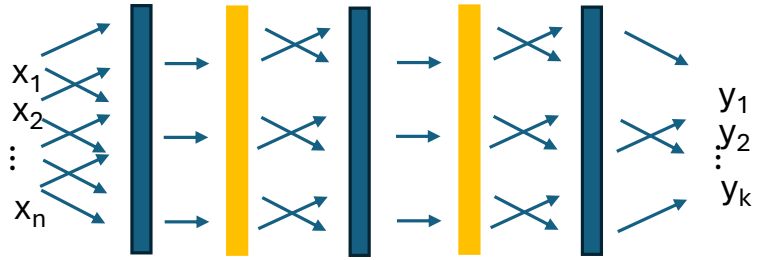


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```

Op

Bi

ReLU → fc3 →y

model = BigNNet()

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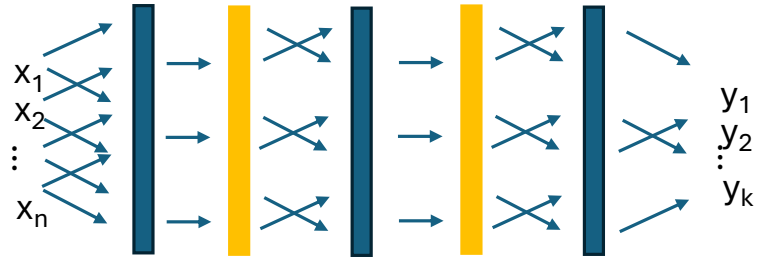


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```

self.fc1 | self.relu | self.fc2 | self.fc3

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        x = self.relu(x)
        x = self.fc3(x)
        return x
```

Op

Bi

ReLU → fc3 → y

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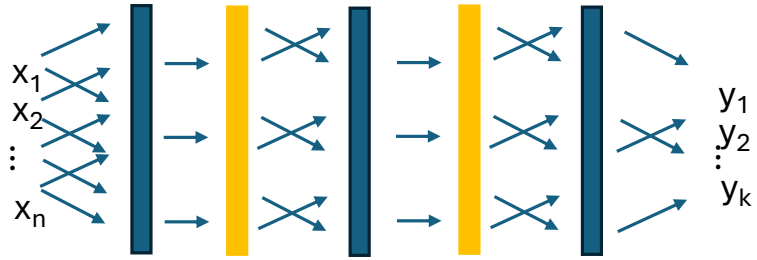


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self.fc1 | self.relu | self.fc2 | self.fc3

ReLU → fc3 → y

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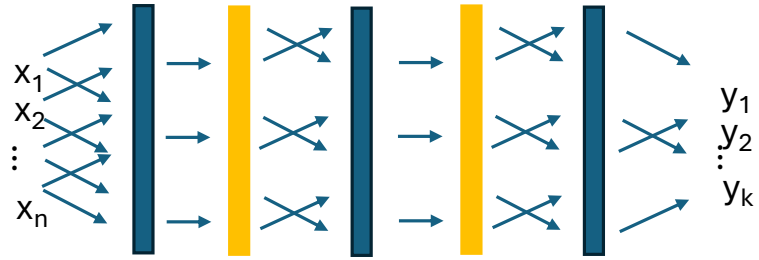


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self.fc1 self.relu self.fc2 self.fc3

ReLU → fc3 →y

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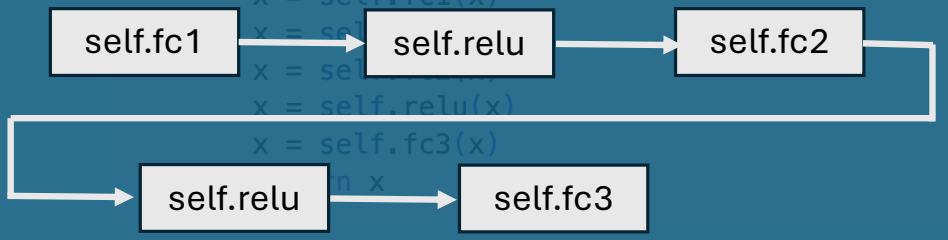
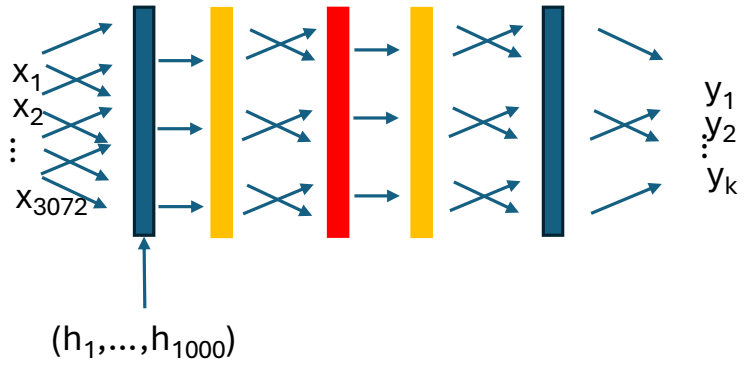


model.fit(X,y)

Η εντολή model.fit(X,y) ψάχνει για παραμέτρους που ελαχιστοποιούν την απώλεια / μεγιστοποιούν την ακρίβεια, στα δεδομένα εκπαίδευσης.



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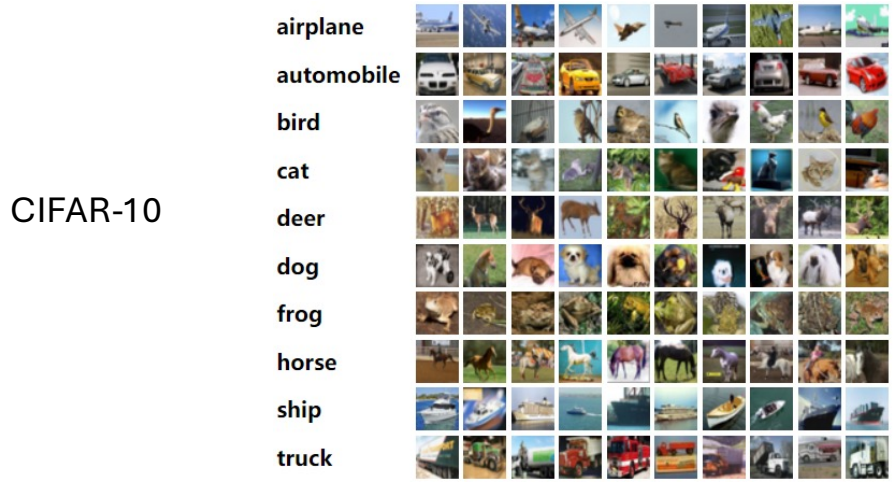
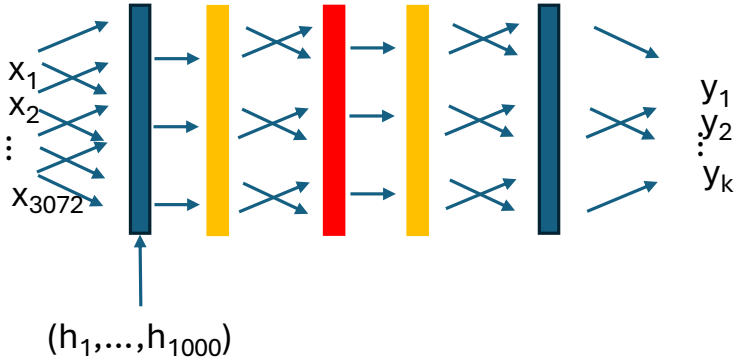


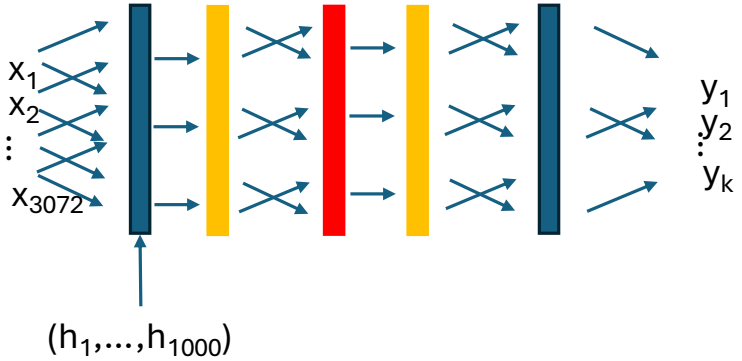
CIFAR-10



model.fit(X,y)

Η εντολή model.fit(X,y) ψάχνει για παραμέτρους που ελαχιστοποιούν την απώλεια / μεγιστοποιούν την ακρίβεια, στα δεδομένα εκπαίδευσης.

Άσκηση: η CIFAR-10 έχει 3.072 features. Εάν το 1ο επίπεδο είναι fully-connected και έχει 1.000 νευρώνες, πόσες παραμέτρους έχει το νευρωνικό δίκτυο μόνο σε αυτό το πρώτο επίπεδο;



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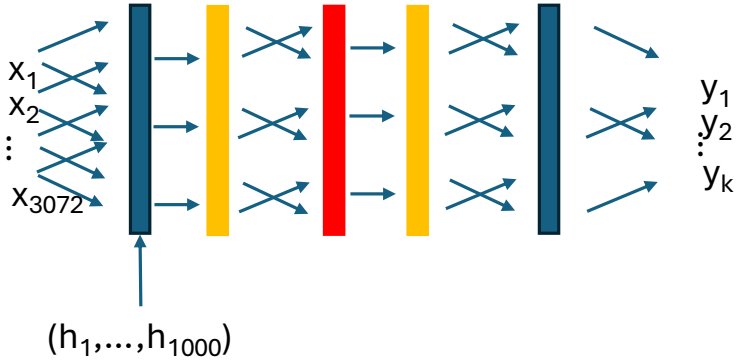
Απάντηση: 3.072 * 1.000 + 1.000 = 3.073.000



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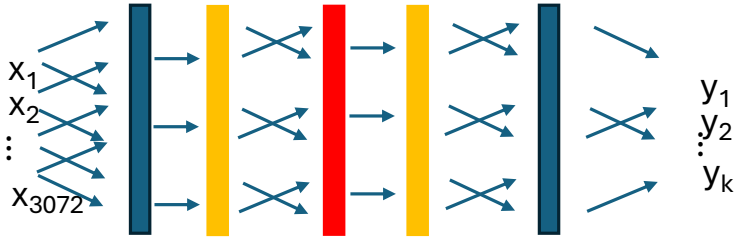
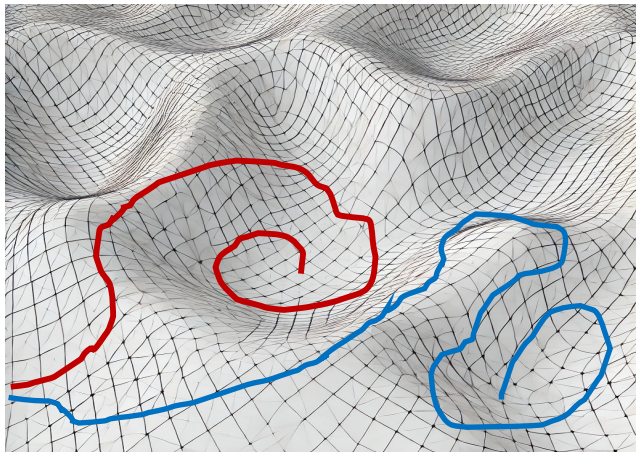


Τα νευρωνικά δίκτυα έχουν **πολλές παραμέτρους**, και η εύρεση των καλύτερων παραμέτρων είναι δύσκολο/αδύνατον.

Αντί αυτού, ψάχνουμε ~~καλύτερες~~ **αρκετά καλές** παραμέτρους.

model.fit(X,y) → train(model, data, **optimizer**, **epochs**)



model.fit(X,y)

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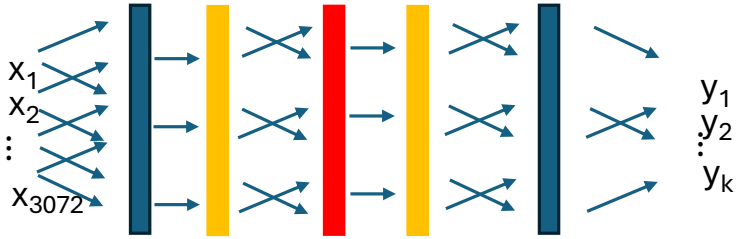

Τα νευρωνικά δίκτυα έχουν **πολλές παραμέτρους**, και η εύρεση των καλύτερων παραμέτρων είναι δύσκολο/αδύνατον.

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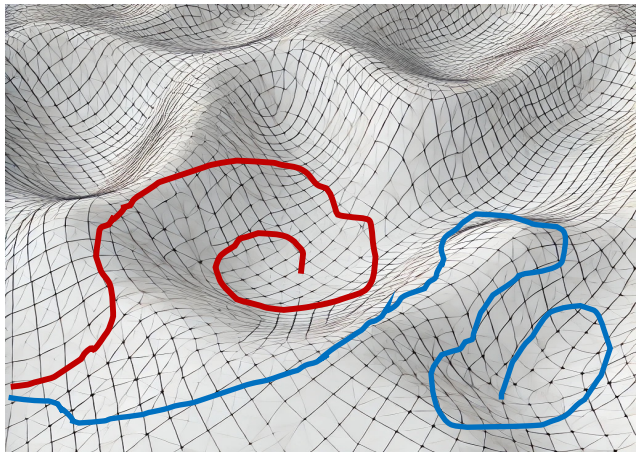
model.fit(X,y) → train(model, data, **optimizer**, **epochs**)

Πώς ψάχνουμε:optim.Adam

πόσο ψάχνουμε



model.predict(x)

model(x)

Πως τα χρησιμοποιούμε

Νευρωνικά Δίκτυα

1. Ορίζουμε τα επίπεδα: MyNeuralNetwork
2. mymodel = MyNeuralNetwork() – ορίζουμε την οικογένεια
3. train(mymodel,data,optimizer,epochs) – βρίσκουμε παραμέτρους που συμφωνούν με (X,y)
4. mymodel(x) – υπολογίζουμε προβλέψεις για τα x