

CS/CE 316/365 Deep Learning

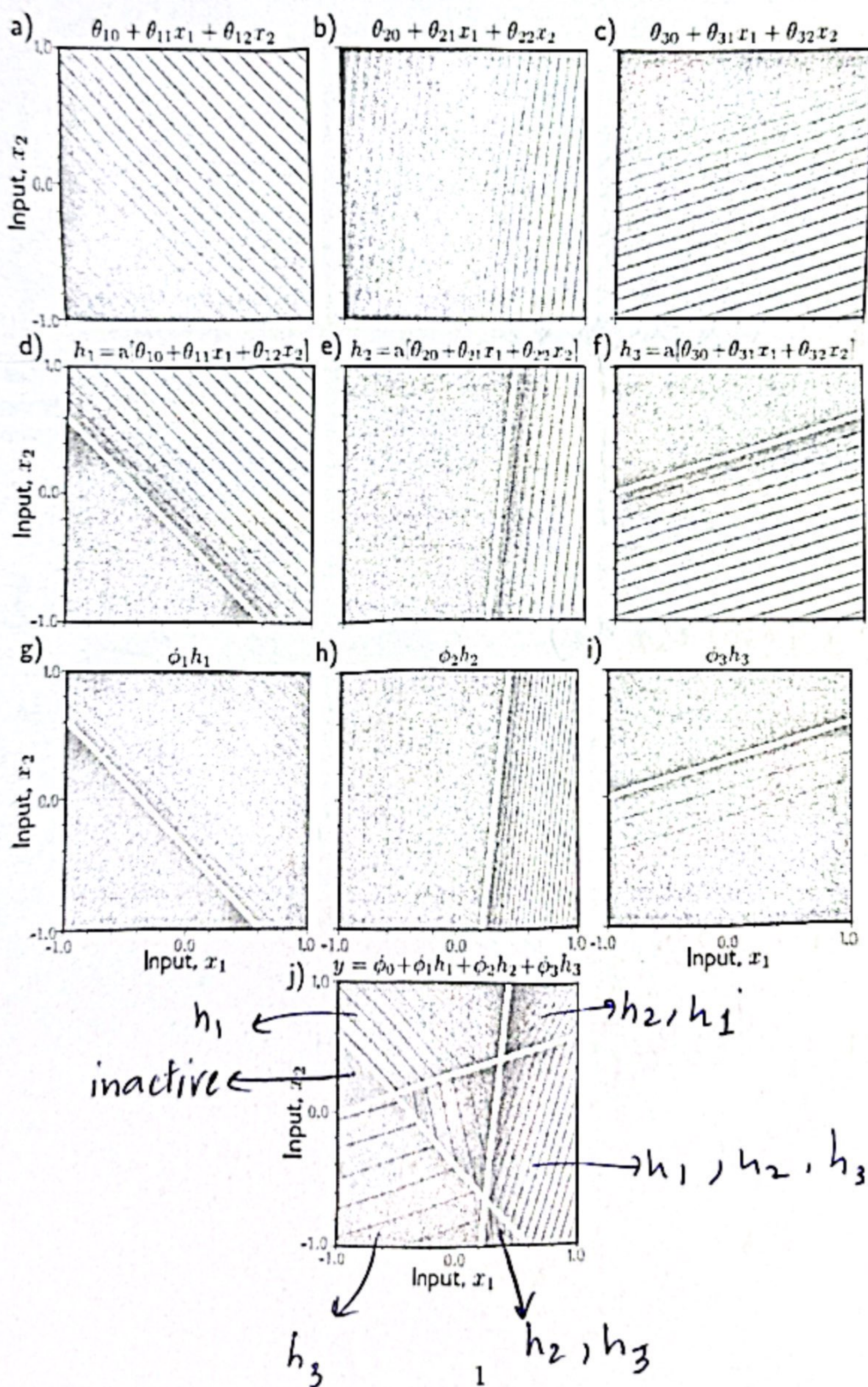
Activity 03

September 4, 2025

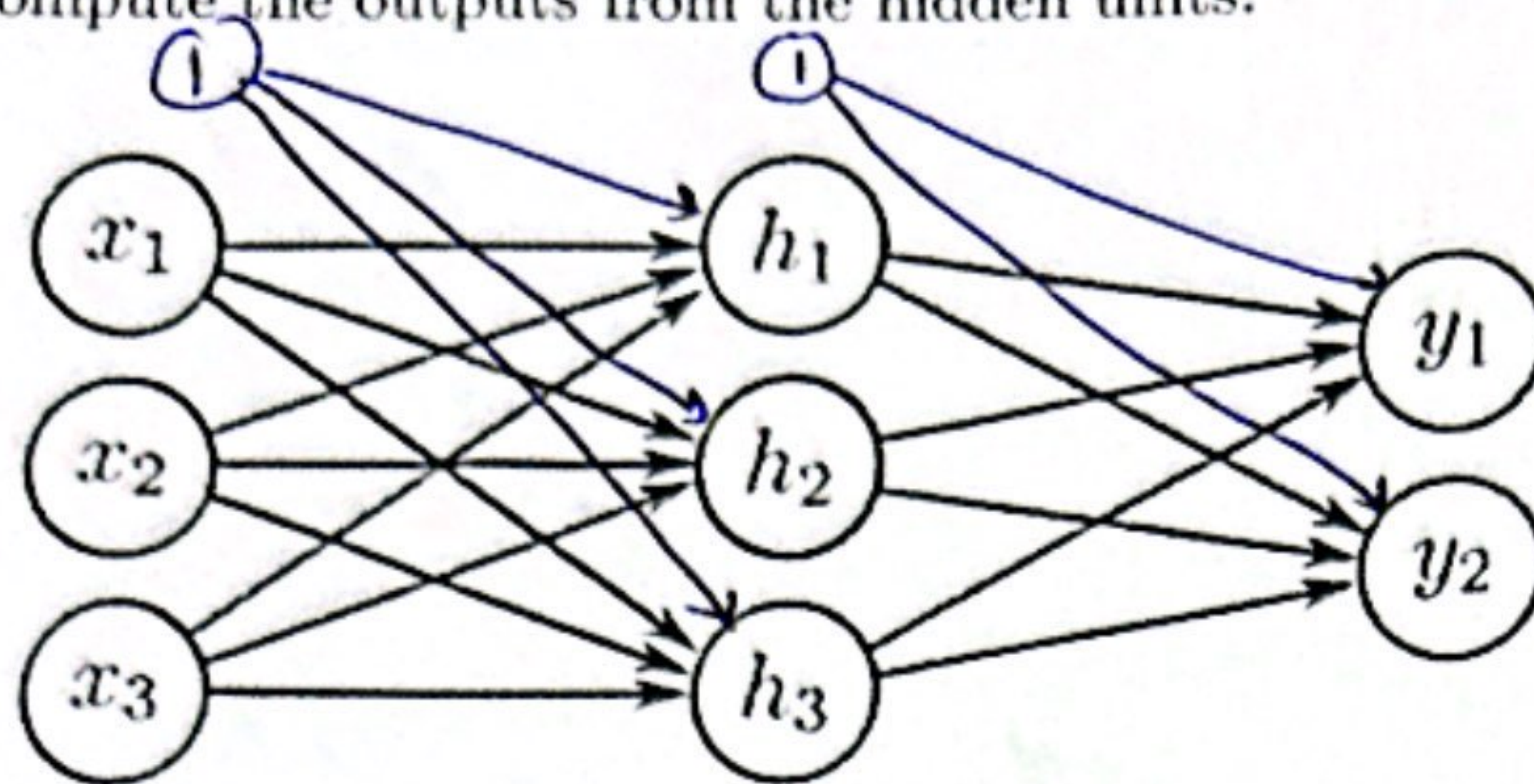
Shallow Neural Networks

Activity needs to be handwritten.

1. Look at the Figure j in this image given below. What is the activation pattern for each of the seven regions in the figure j? In other words, which hidden units are active (pass the input) and which are inactive (clip the input) for each region? Three hidden units are h_1 , h_2 and h_3 .



2. Write out the equations that define the network in figure given below. There should be three equations to compute the three hidden units from the inputs and two equations to compute the outputs from the hidden units.



$$h_1 = a[\theta_{10} + \theta_{11}x_1 + \theta_{12}x_2 + \theta_{13}x_3]$$

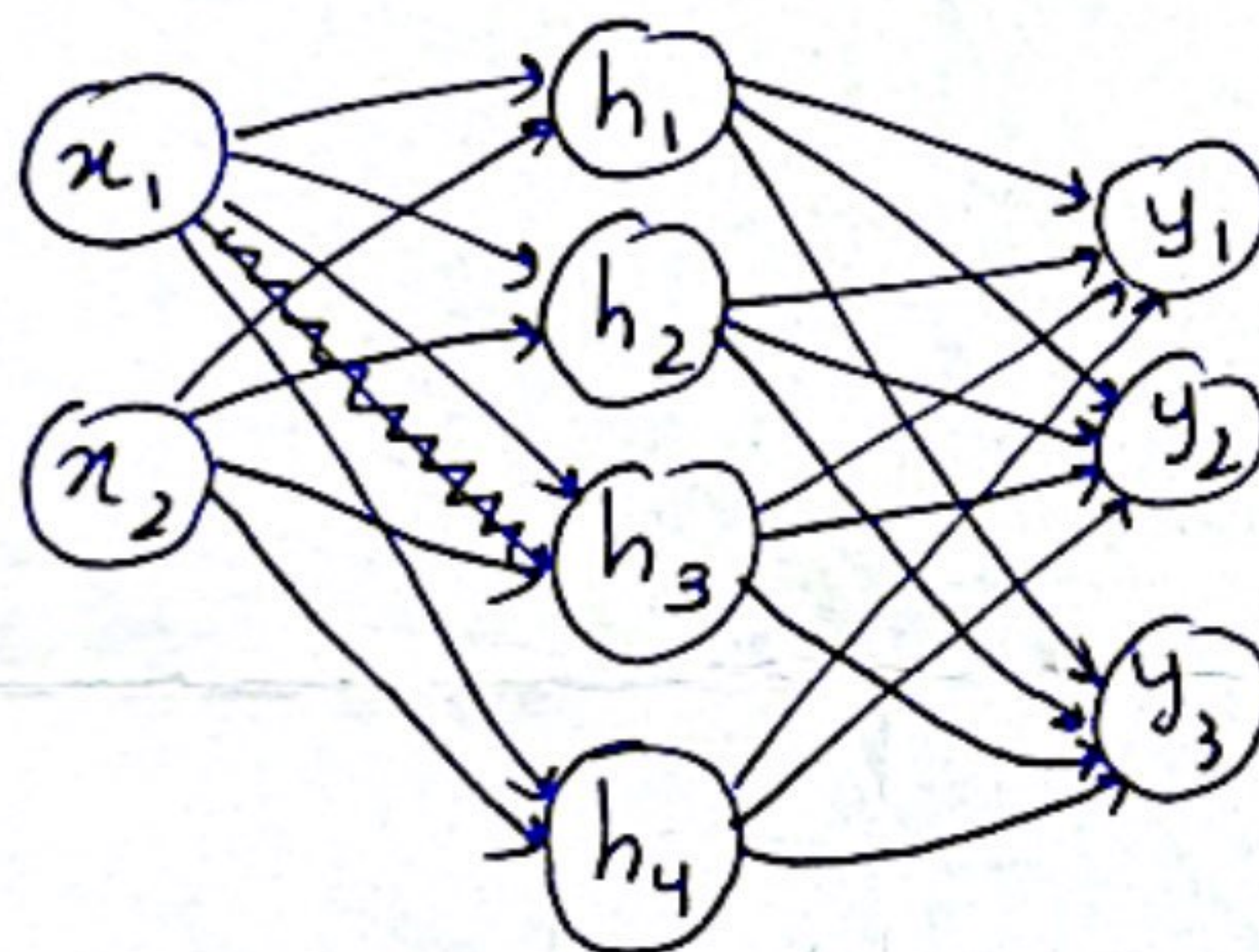
$$h_2 = a[\theta_{20} + \theta_{21}x_1 + \theta_{22}x_2 + \theta_{23}x_3]$$

$$h_3 = a[\theta_{30} + \theta_{31}x_1 + \theta_{32}x_2 + \theta_{33}x_3]$$

$$y_1 = \phi_{10} + \phi_{11}h_1 + \phi_{12}h_2 + \phi_{13}h_3$$

$$y_2 = \phi_{20} + \phi_{21}h_1 + \phi_{22}h_2 + \phi_{23}h_3$$

3. What is the maximum possible number of 3D linear regions that can be created by the network in figure in previous question? $\sum_{j=0}^D \binom{D}{j} = \binom{3}{0} + \binom{3}{1} + \binom{3}{2} + \binom{3}{3} = 1 + 3 + 3 + 1 = 8$
4. Write out the equations for a network with two inputs, four hidden units, and three outputs. Draw this model in the style of above given figure.



$$h_1 = a(\theta_{10} + \theta_{11}x_1 + \theta_{12}x_2)$$

$$h_2 = a(\theta_{20} + \theta_{21}x_1 + \theta_{22}x_2)$$

$$h_3 = a(\theta_{30} + \theta_{31}x_1 + \theta_{32}x_2)$$

$$h_4 = a(\theta_{40} + \theta_{41}x_1 + \theta_{42}x_2)$$

$$y_1 = \phi_{10} + \phi_{11}h_1 + \phi_{12}h_2 + \phi_{13}h_3 + \phi_{14}h_4$$

$$y_2 = \phi_{20} + \phi_{21}h_1 + \phi_{22}h_2 + \phi_{23}h_3 + \phi_{24}h_4$$

$$y_3 = \phi_{30} + \phi_{31}h_1 + \phi_{32}h_2 + \phi_{33}h_3 + \phi_{34}h_4$$