HW4

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1 Pose Estimatiom

1.a

```
Nc =

    0.8313   -0.5542    0.0429
    0.8298    0.5532    0.0727
    0.8480    0.5300    0.0094
    0.8174   -0.5682    0.0944
    0.8497   -0.5270   -0.0173
    0.7894    0.6024    0.1179
    0.0948    0.9950    0.0331
    0.1171    0.9892    0.0877
    0.0365    0.9988   -0.0338
```

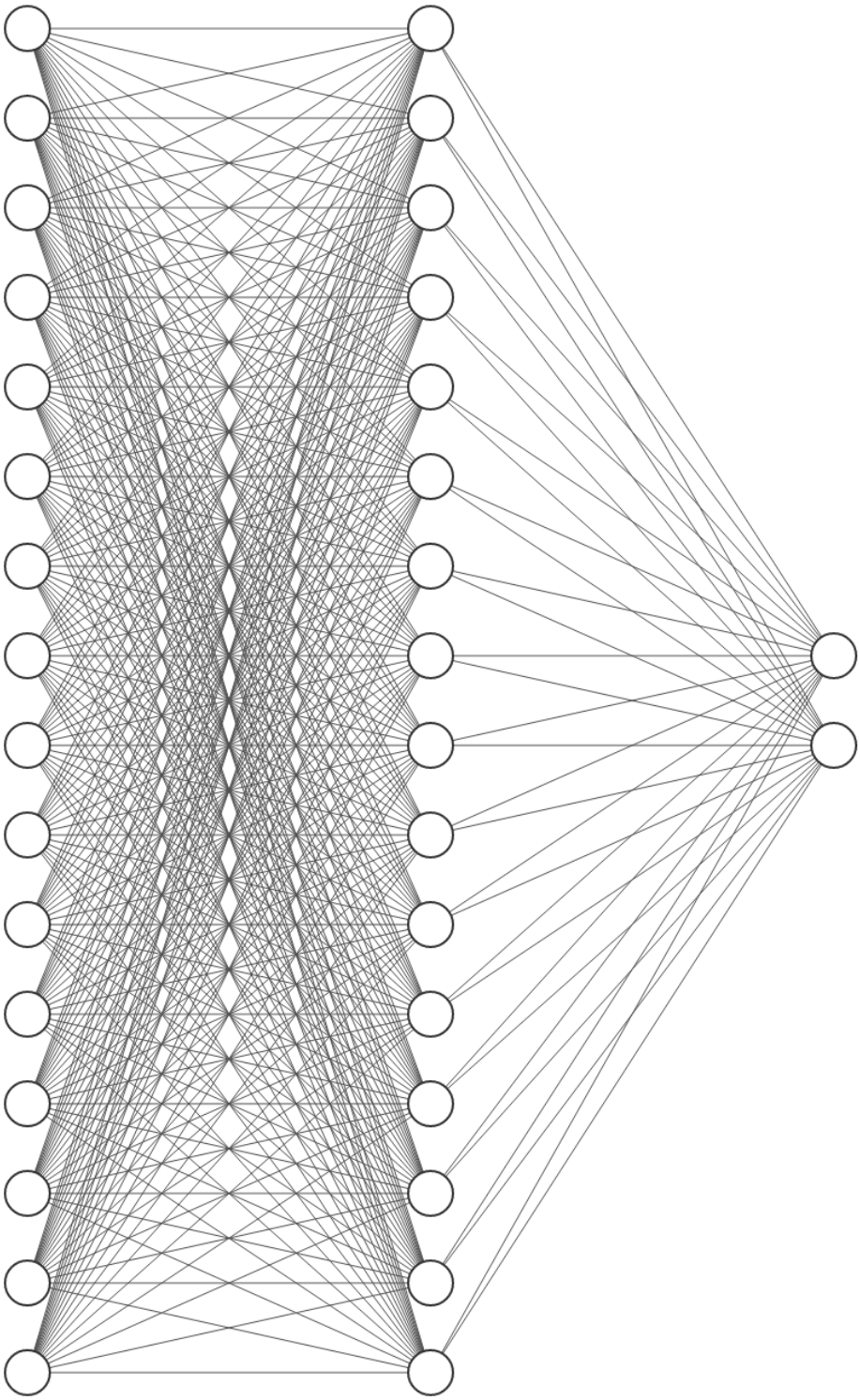
1.b

```
R =

    0.0188    0.1104    0.5660
   -0.2164   -0.0236    1.3489
    0.0268    0.0654    0.2118


T =

   -0.2555
   -0.7265
    0.4455
```

2. Artificial Neural Network

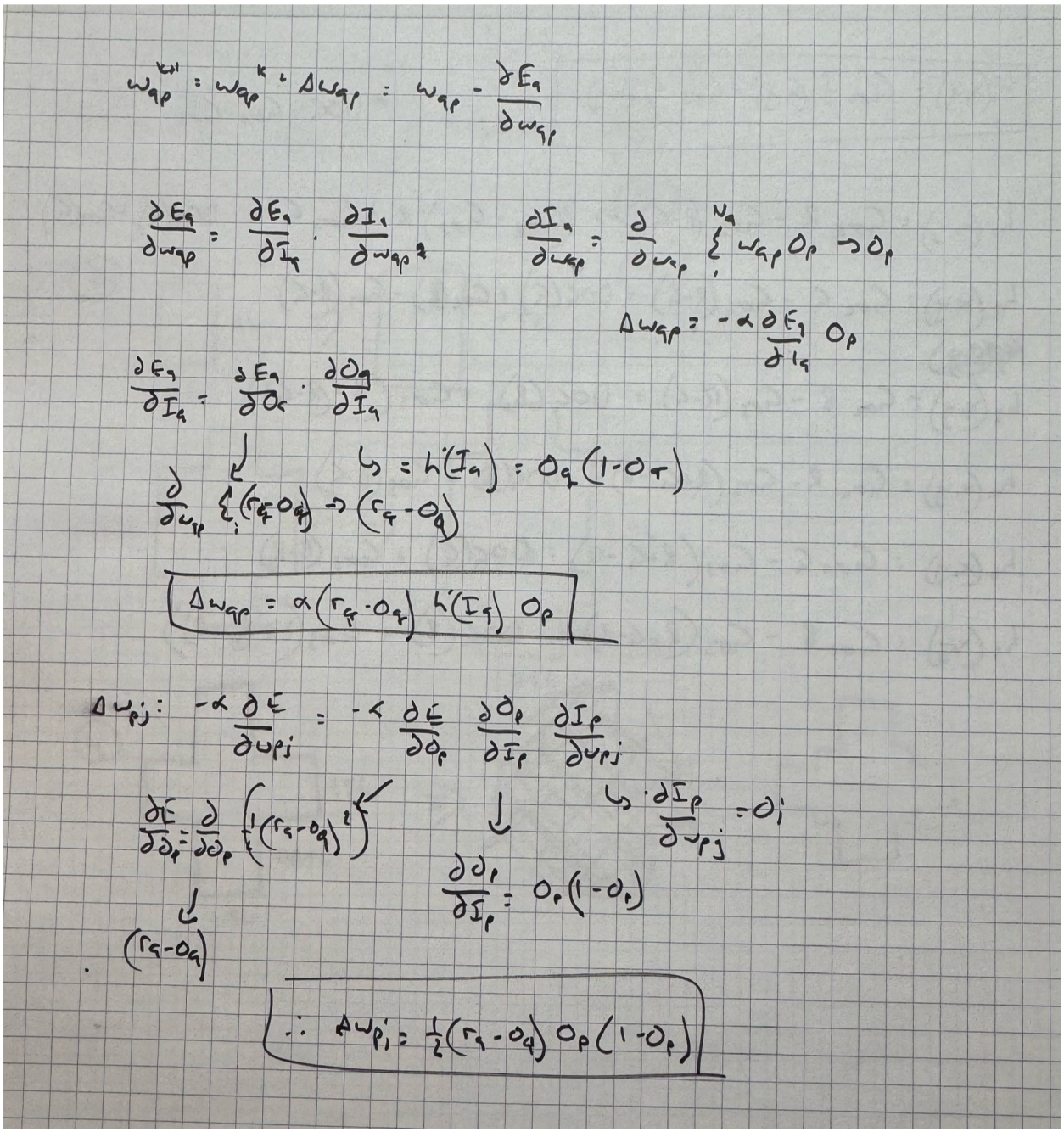
2.a

There is 1 hidden layer, 16 inputs for each pixel, and 2 outputs for the 2 different structures.

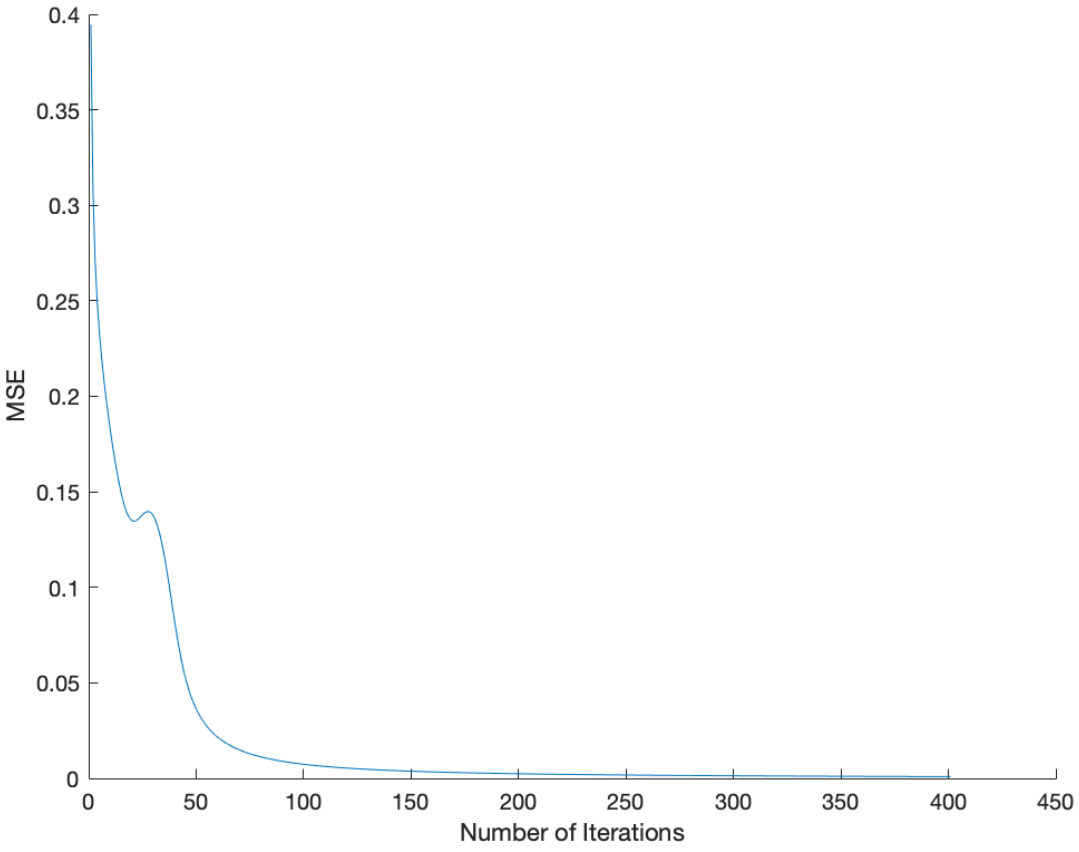


Input Layer $\in \mathbb{R}^{16}$ Hidden Layer $\in \mathbb{R}^{16}$ Output Layer $\in \mathbb{R}^{2}$

2.b


$w_{qp}^{k+1} = w_{qp}^{k} + \Delta w_{qp} = w_{qp} - \frac{\partial E_q}{\partial w_{qp}}$
$\frac{\partial E_q}{\partial w_{qp}} = \frac{\partial E_q}{\partial I_q} \cdot \frac{\partial I_q}{\partial w_{qp}}$
$\frac{\partial I_q}{\partial w_{qp}} = \frac{\partial}{\partial w_{qp}} \sum_i^{N_q} w_{qp} O_p \rightarrow O_p$
$\Delta w_{qp} = -\alpha \frac{\partial E_q}{\partial I_q} O_p$
$\frac{\partial E_q}{\partial I_q} = \frac{\partial E_q}{\partial O_q} \cdot \frac{\partial O_q}{\partial I_q}$
$\frac{\partial}{\partial w_{qp}} \sum_i (r_q - O_q) \rightarrow (r_q - O_q)$
$\hookrightarrow h'(I_q) = O_q(1 - O_q)$
$\Delta w_{qp} = \alpha (r_q - O_q) h'(I_q) O_p$
$\Delta w_{pj} = -\alpha \frac{\partial E}{\partial w_{pj}} = -\alpha \frac{\partial E}{\partial O_p} \frac{\partial O_p}{\partial I_p} \frac{\partial I_p}{\partial w_{pj}}$
$\frac{\partial E}{\partial O_p} = \frac{\partial}{\partial O_p} \left(\frac{1}{2} \sum_i (r_q - O_q)^2 \right)$
$\hookrightarrow \frac{\partial I_p}{\partial w_{pj}} = O_j$
$\frac{\partial O_p}{\partial I_p} = O_p(1 - O_p)$
$(r_q - O_q)$
$\therefore \Delta w_{pj} = \frac{1}{2} (r_q - O_q) O_p (1 - O_p)$

2.c


0.4
0.35
0.3
0.25
0.2
0.15
0.1
0.05
0
MSE
0
50
100
150
200
250
300
350
400
450
Number of Iterations

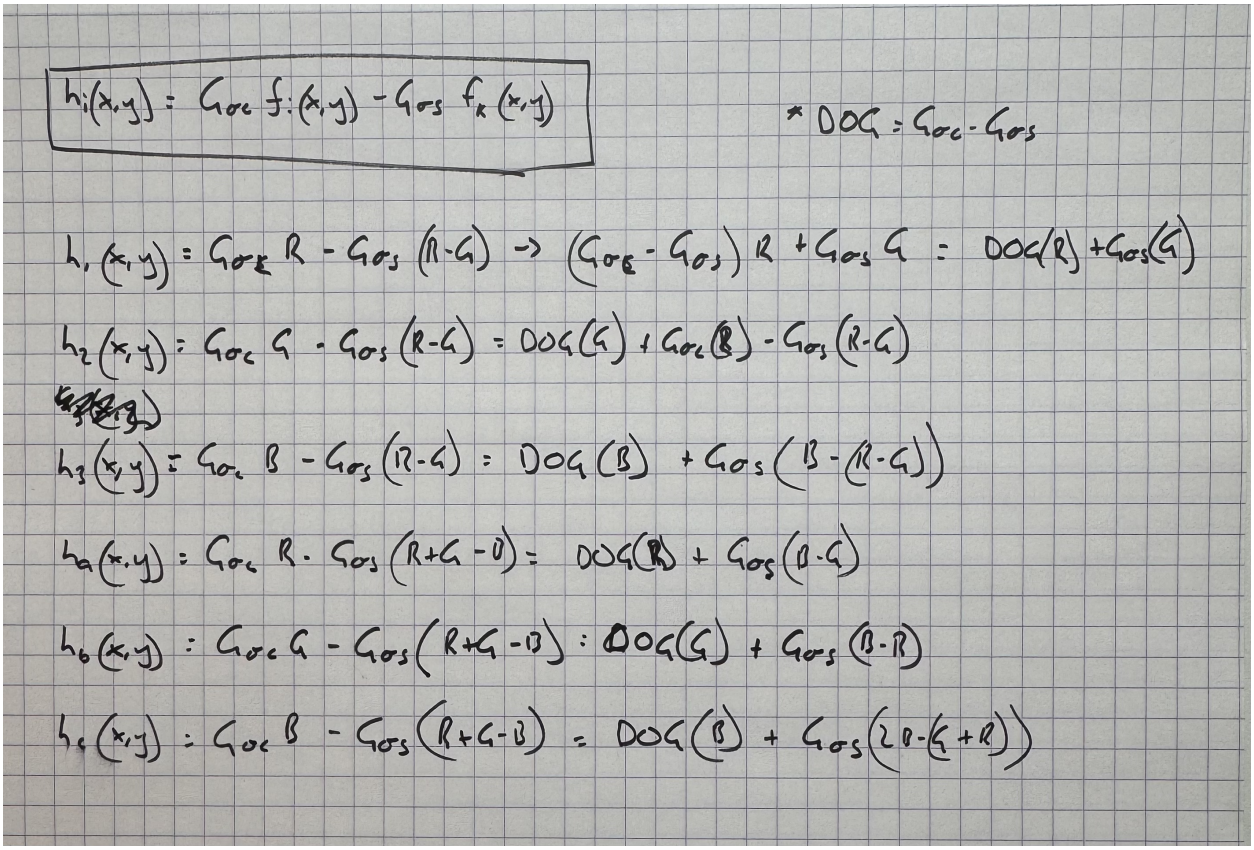
2.d

```
o1 =

    0.0154
    0.9813


o2 =

    0.0569
    0.8955


o3 =

    0.4485
    0.3495
```

Based on the output values, the model seems to predict the structure with accuracy.

3. Color

3.I ACC



1-2-3

1-2-c

1-b-3

1-b-c

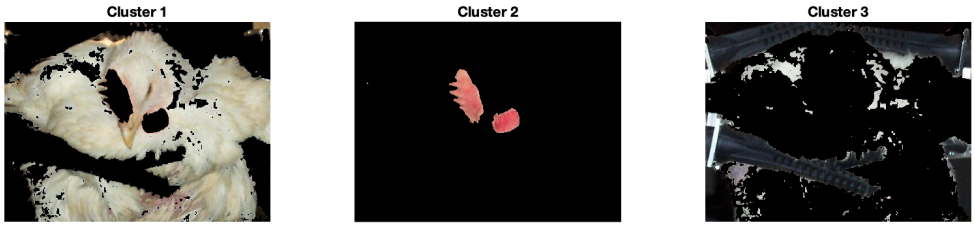
a-2-3

a-2-c

a-b-3

a-b-c

3.II Color-based Image Segmentation



3.III PCA

```
C =

    0.0824    0.0773    0.0665
    0.0773    0.0773    0.0670
    0.0665    0.0670    0.0594


V =

    0.6109    0.5973    0.5197
    0.7720   -0.3038   -0.5584
   -0.1756    0.7423   -0.6467


D =

    0.2146
    0.0039
    0.0006
```