COMP9444 Neural Networks and Deep Learning

Assignment1

Part1

1.

```
<class 'numpy.ndarray'>
[[765.   5.   9.  13.  30.  63.   2.  62.  32.  19.]
 [  7. 668. 110.  17.  30.  21.  57.  14.  26.  50.]
 [  8.  63. 692.  26.  26.  21.  46.  35.  45.  38.]
 [  5.  33.  61. 759.  15.  55.  16.  17.  28.  11.]
 [ 62.  51.  77.  20. 628.  19.  32.  36.  20.  55.]
 [  8.  27. 126.  17.  20. 725.  26.   8.  32.  11.]
 [  5.  20. 150.   9.  27.  26. 719.  22.   9.  13.]
 [ 18.  27.  27.  12.  85.  15.  55. 623.  89.  49.]
 [ 11.  37.  92.  41.   8.  30.  46.   7. 706.  22.]
 [  8.  52.  86.   4.  53.  31.  19.  31.  39. 677.]]

Test set: Average loss: 1.0096, Accuracy: 6962/10000 (70%)
```

2.

```
[[852.   2.   1.   6.  27.  33.   4.  39.  28.   8.]
 [  5. 814.  32.   3.  18.  11.  61.   6.  16.  34.]
 [  7.  13. 833.  41.  15.  20.  26.  10.  19.  16.]
 [  4.   4.  28. 927.   2.  13.   7.   2.   7.   6.]
 [ 36.  21.  18.   8. 833.   9.  24.  16.  20.  15.]
 [  9.  10.  78.  10.  13. 839.  21.   1.  14.   5.]
 [  3.  12.  57.   9.  19.   2. 886.   7.   1.   4.]
 [ 16.  11.  23.   5.  24.   8.  29. 826.  24.  34.]
 [ 11.  28.  32.  50.   2.   8.  35.   3. 823.   8.]
 [  2.  14.  48.   6.  29.   5.  20.  19.  11. 846.]]

Test set: Average loss: 0.4970, Accuracy: 8479/10000 (85%)
```

3.

```
[[961.   5.   0.   0.  19.   1.   0.   7.   2.   5.]
 [  1. 950.   6.   0.   6.   1.  19.   1.   4.  12.]
 [  9.  11. 906.  43.   6.   6.   5.   4.   3.   7.]
 [  2.   1.  12. 961.   0.   3.  11.   3.   2.   5.]
 [ 18.  17.   2.   4. 938.   0.   3.   8.   6.   4.]
 [  2.  12.  36.   5.   5. 904.  19.   0.   3.  14.]
 [  3.   4.  11.   0.   5.   1. 971.   3.   0.   2.]
 [  4.   3.   4.   0.   2.   0.   5. 966.   3.  13.]
 [  7.  20.   5.   1.   8.   0.   5.   1. 948.   5.]
 [  5.   5.  10.   0.   6.   0.   4.   4.   6. 960.]]

Test set: Average loss: 0.2255, Accuracy: 9465/10000 (95%)
```

4.

a.

It can be seen from the above that the correct rate of the Netlin model is about 70%. The NetFull model sets hidden nodes to 300 after many adjustments, and the correct rate is about 85%. After simple adjustments, the correct rate of the NetConv model is as high as about 95%, it can be seen that the highest correct rate is the NetConv model, and the lowest is the Netlin model.

b.

Find the largest number in the matrix except the diagonal. Although the results of each run will be different due to randomness and computer performance, the largest number is unique. Let the numeric column number and row number at the beginning of the matrix be 1.

From the first model, the largest number is in row 7, column 3

"ma" is most likely to be mistakenly identified as "su".

From the second model, the largest number is in row 6, column 3

"ha" is most likely to be mistakenly identified as "su".

From the third model, the largest number is in row 6, column 3

"ha" is most likely to be mistakenly identified as "su".

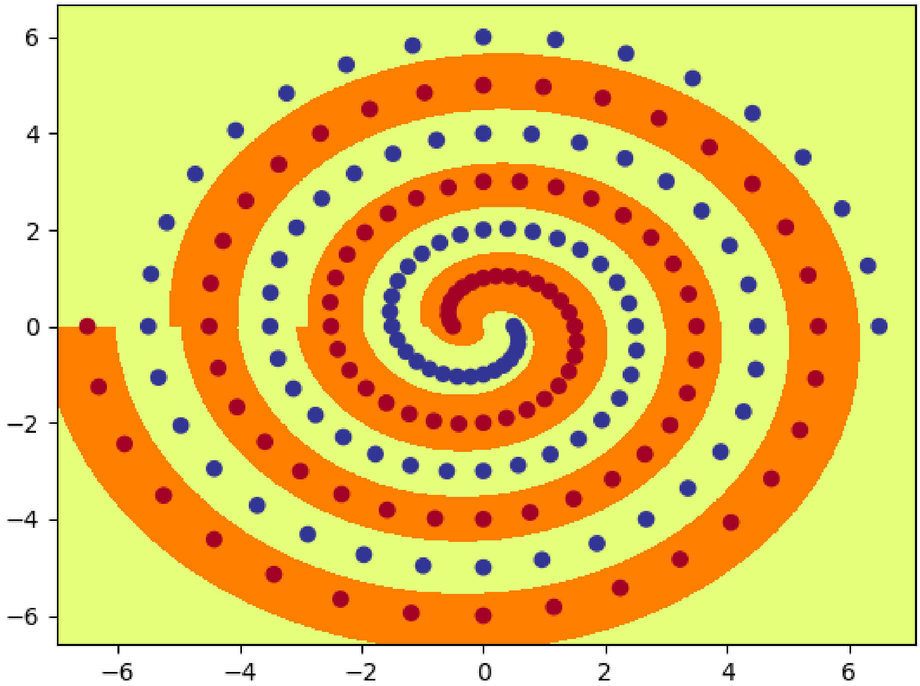
First of all, the recognition cannot be 100% correct. In my opinion, different models have different emphasis on recognition, so in the end it will cause different wrong recognition results. From the results, the handwriting of “su” is very similar to “ha” and “ma”.

c.

I changed the model in Net full from two to three layers, and used the original hidden nodes value as the first hidden nides value, and after repeated testing and modification, the value of the second layer was increased from 300 to 600, and the overall accuracy rate remained stable at about 87% without much change, but compared with the single-layer neural network, the accuracy rate increased by 2%. However, after reducing the two values to 100 respectively, the accuracy rate is also reduced to about 86%. And from the value it can be seen that the accuracy rate is greatly affected by the first layer. From this, it can be concluded that the two-layer neural network compared with the single layer, the upper limit of the correct rate has been improved.

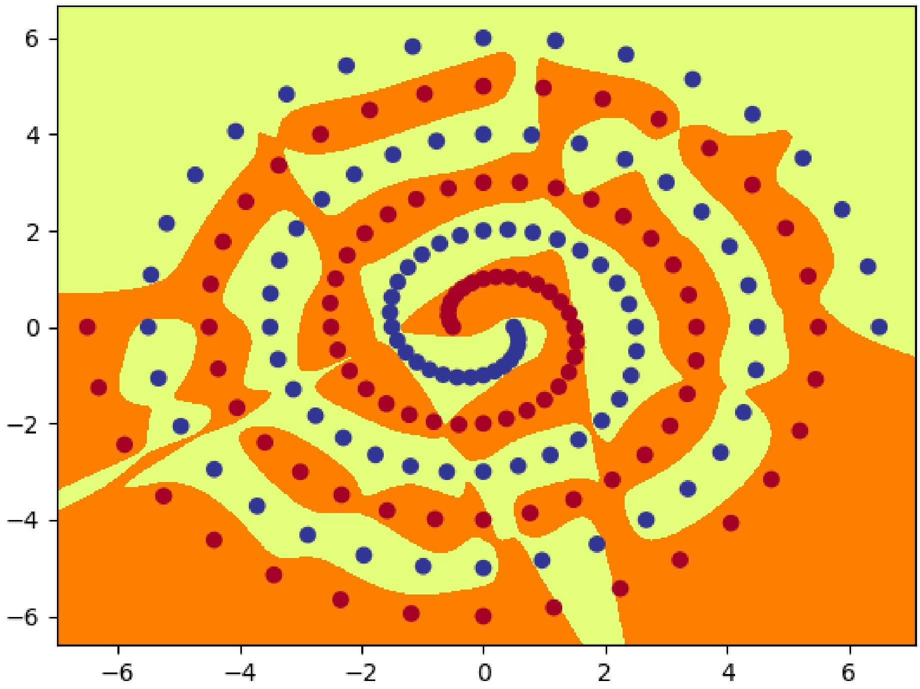
Part2

2



The minimum number of hidden nodes required is 8. Actually, I have tried the number from 2 to 10, when it come to 7, most of the tests it can correctly classify all of the training data within 20000 epochs, only one test it could not meet the requirement. So, the minimum number should be 8.

4.

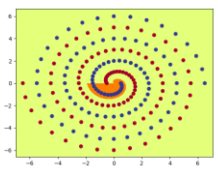
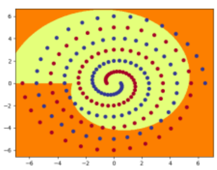
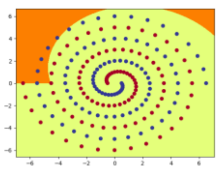
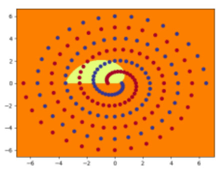
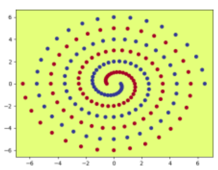
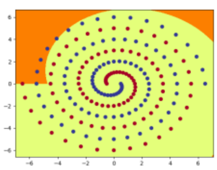
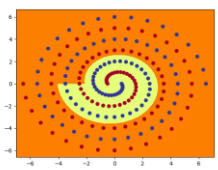
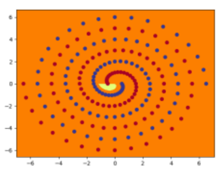
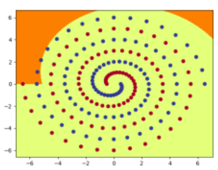
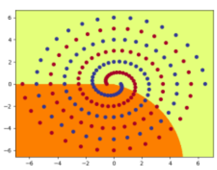
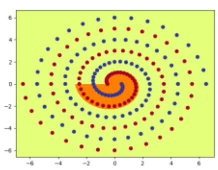
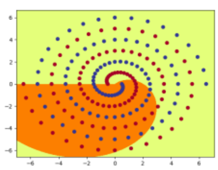


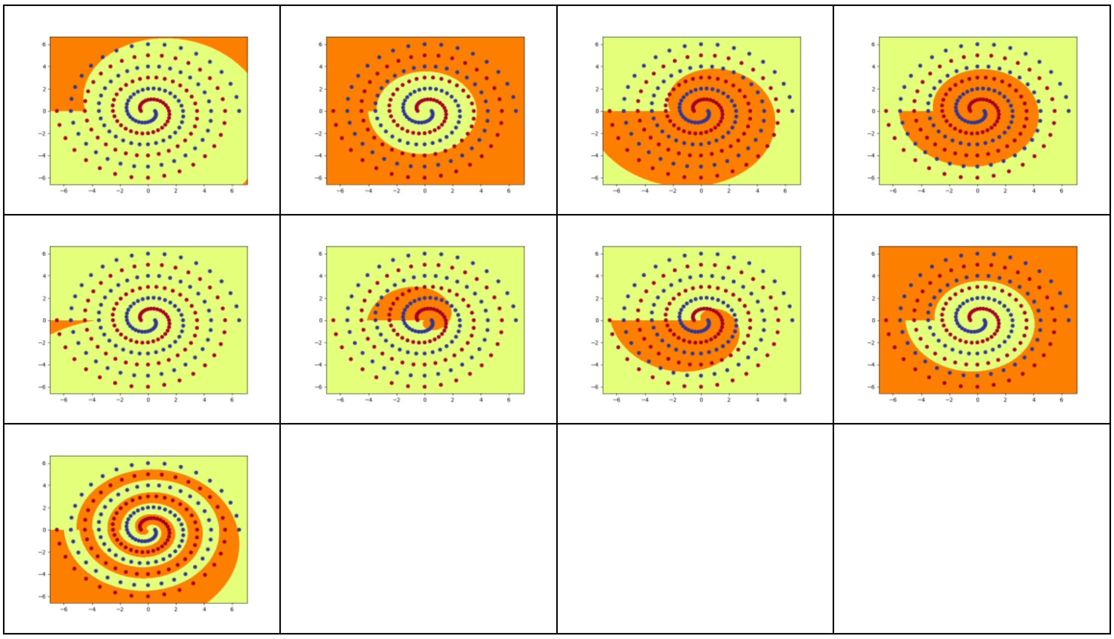
The output is choosing the number of hidden nodes is 20 and the weight is 0.5, and it is found that the higher the value of hid, the faster the convergence.

5.

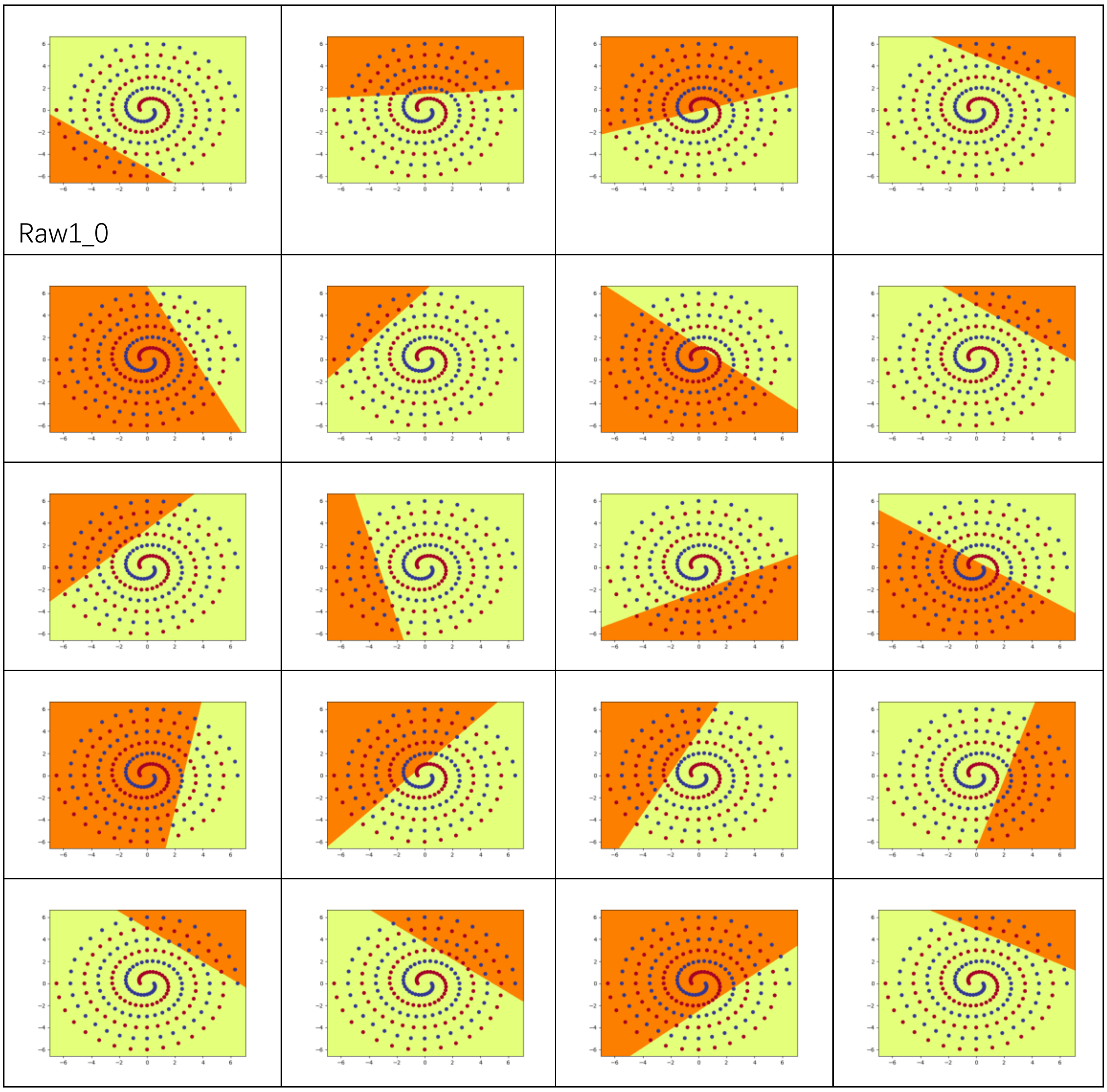
In order to save space, I loaded the pictures into the table in order, and the last one is the final output.

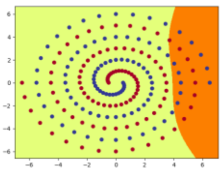
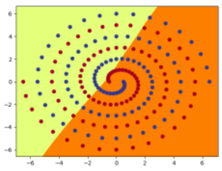
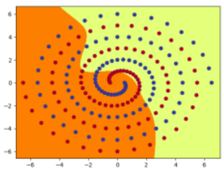
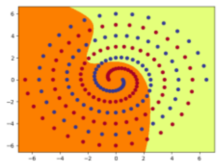
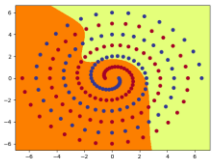
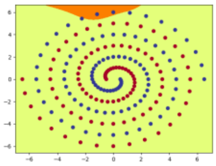
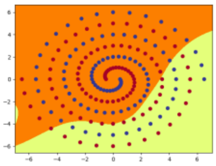
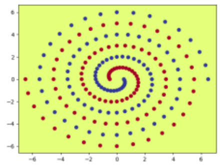
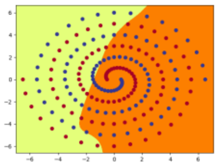
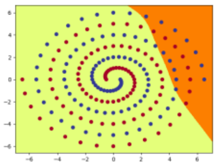
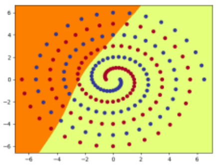
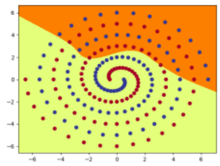
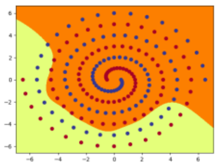
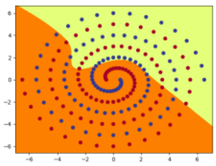
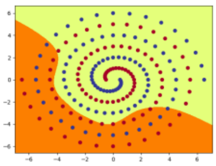
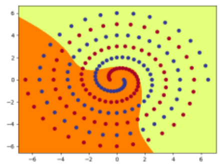
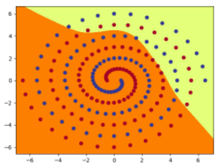
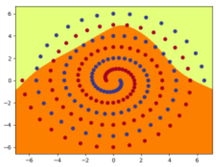
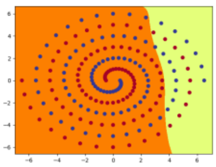
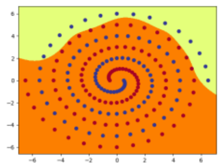
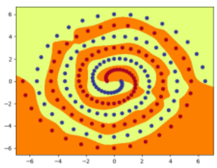
Polar:



Raw:



 Raw2_0			
			
			
			
			
			

6.

a.

From the fifth question above, in order to reduce the difference, Raw did not set the initial weight and the hidden nodes are the same 20.

In terms of operating speed, polar reaches a percentage at ep: 1800, while Raw reaches a percentage at ep: 4400. The polar model runs faster than the raw model.

From the perspective of hidden images, polar is more inclined to follow the original trajectory of the graphics to judge and classify, while raw is inclined to linear classification. As a result, they have reached 100% accuracy, but polar images are clearer and better to recognize.

b.

After many tests and discovering that when the hid value is constant, set it to 20. Although the running results of the same initial weight fluctuate, it can be found that the convergence speed is faster between 0.4 and 0.7, the value tends to slower at 0.9 and slowest at area 0.1. But it has little effect on the final success rate, all of them reached 100% in my tests.

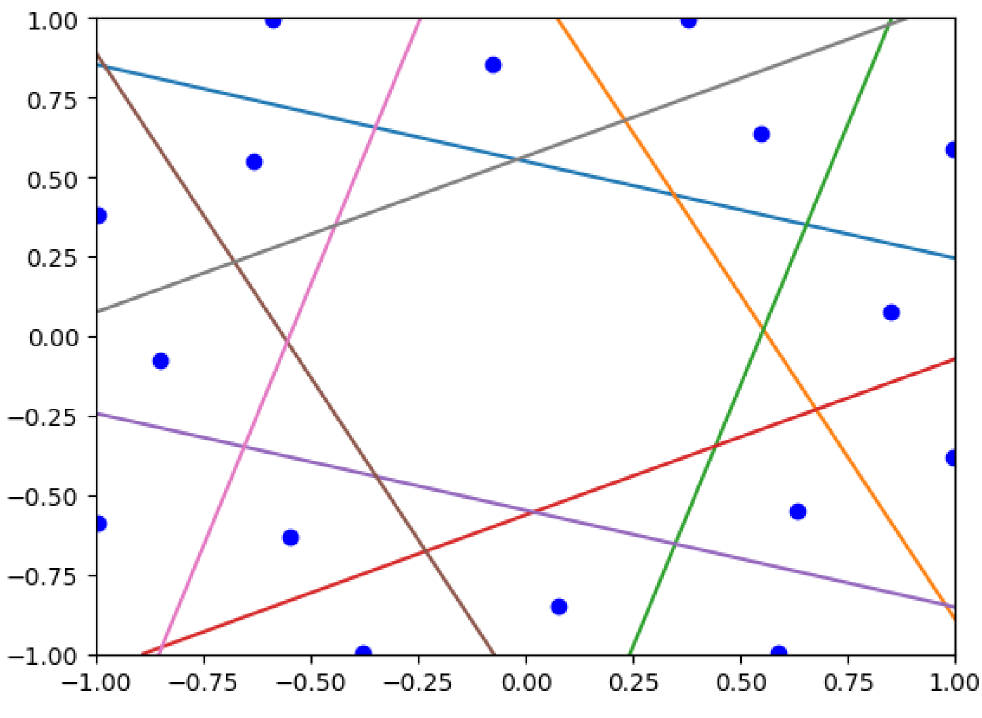
c.

I changed the tanh in the polar model to relu, and tested it under the condition of hid=10. The original model quickly reached 100% accuracy and stopped running, but after changing to relu, the accuracy rate fluctuates around 65%. I manually terminated the program after the ep value was tens of thousands. After changing hid to 20 to speed up the convergence rate, the same result was obtained, which proved that relu might not be suitable for use in this model.

After looking up the information, I speculated that perhaps because the gradient of the data flowing through the relu in the model is large, the gradient is updated to a special state, in which the neuron will not be able to be activated again by any other data points. So, the training data is no longer updated, which is equivalent to "dead".

Part3

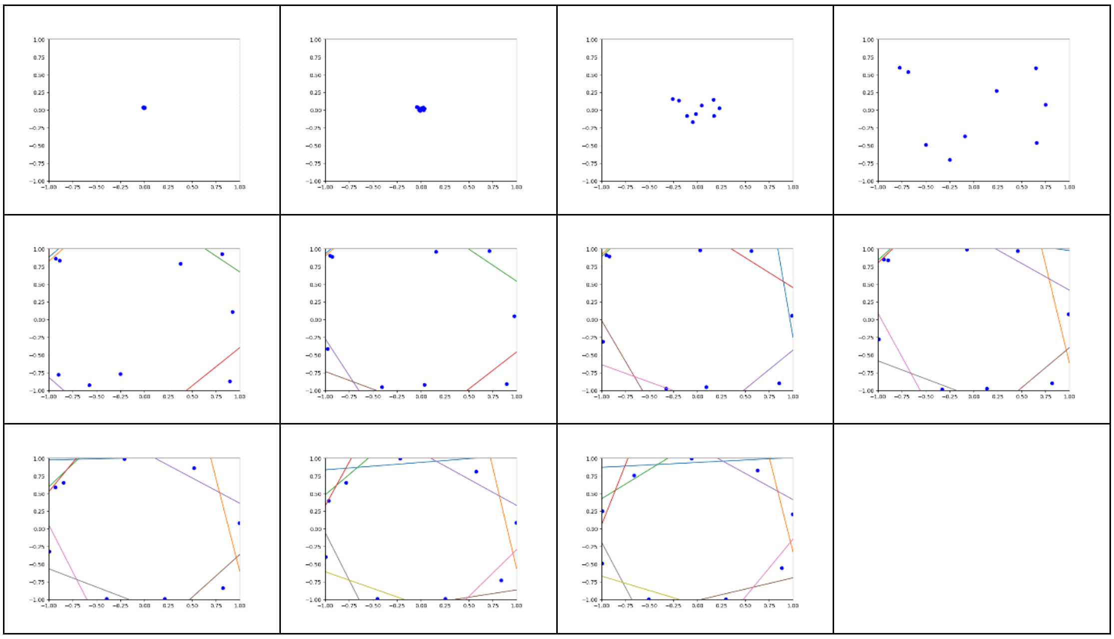
1.The final image of star16:



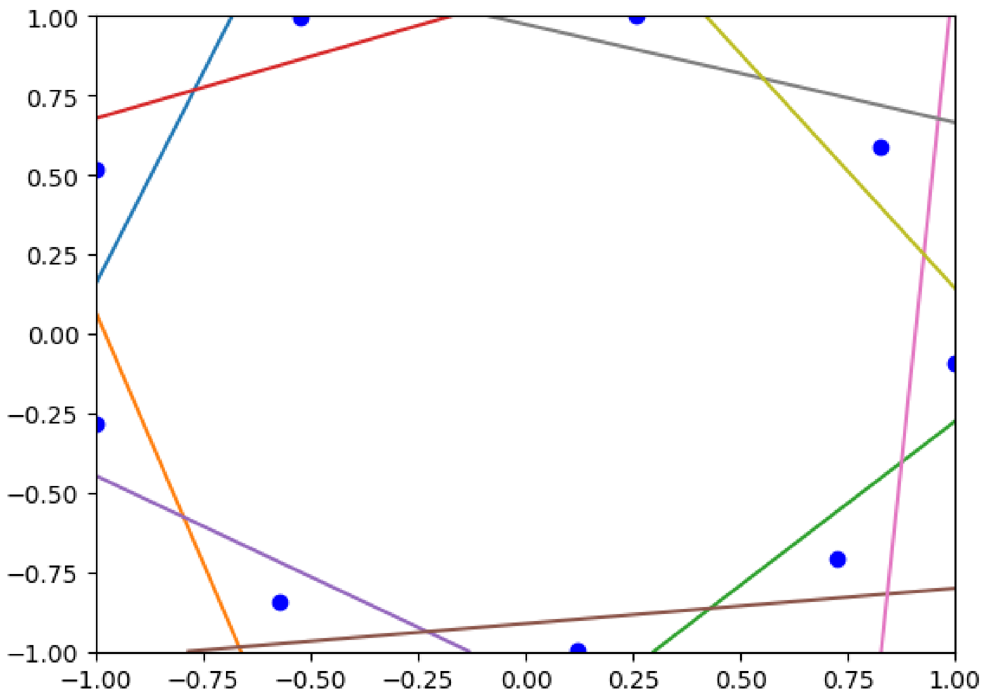
2.

In order to save space, the first 11 pictures are scaled down and put into the table in order, and the final result picture is outside the table and is filled with the appropriate size.

Although the first 11 pictures are not clear after this report being converted to pdf, the trend of change is still clear.

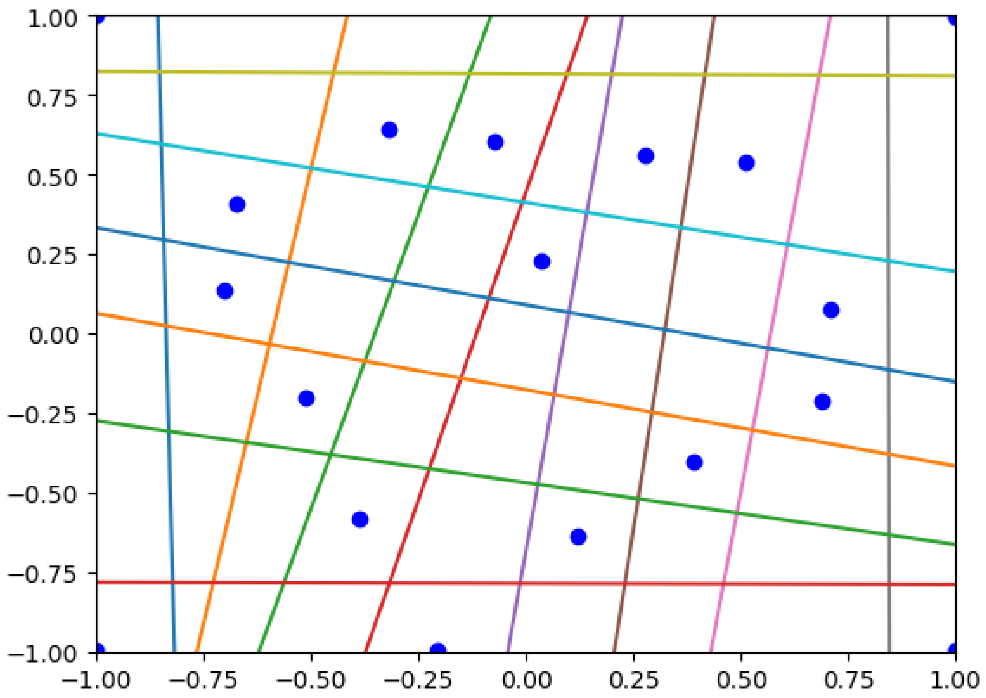


The final output.



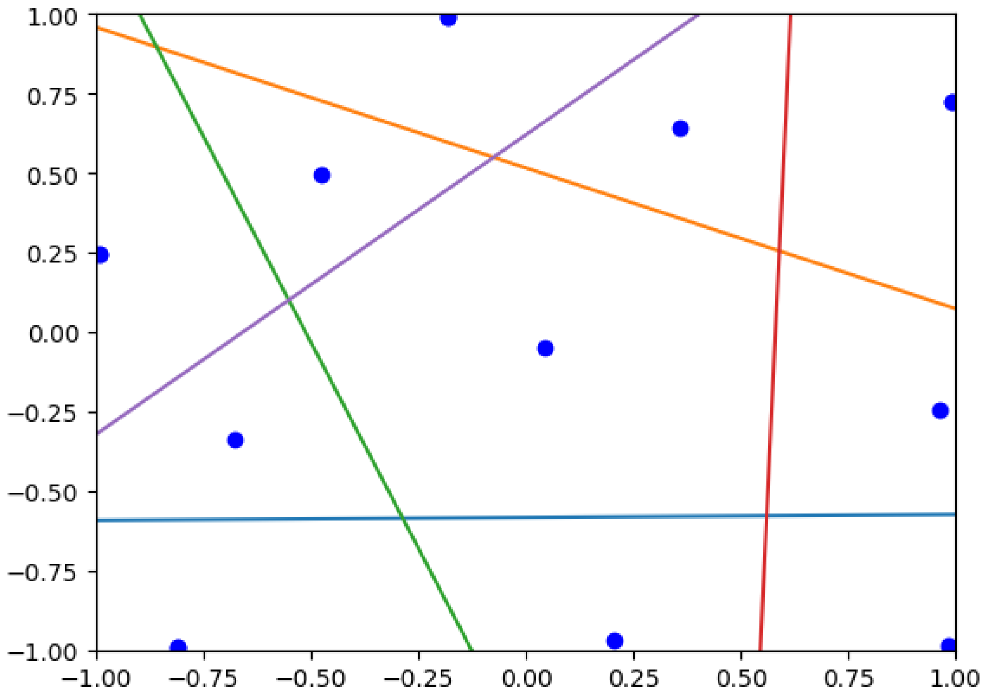
Judging from the change trend of the above image, Hidden unit activations will gather together at the beginning, and will gradually spread out as the number of iterations increases. At the same time, the output boundaries will distinguish the hidden units according to the established rules.

3.



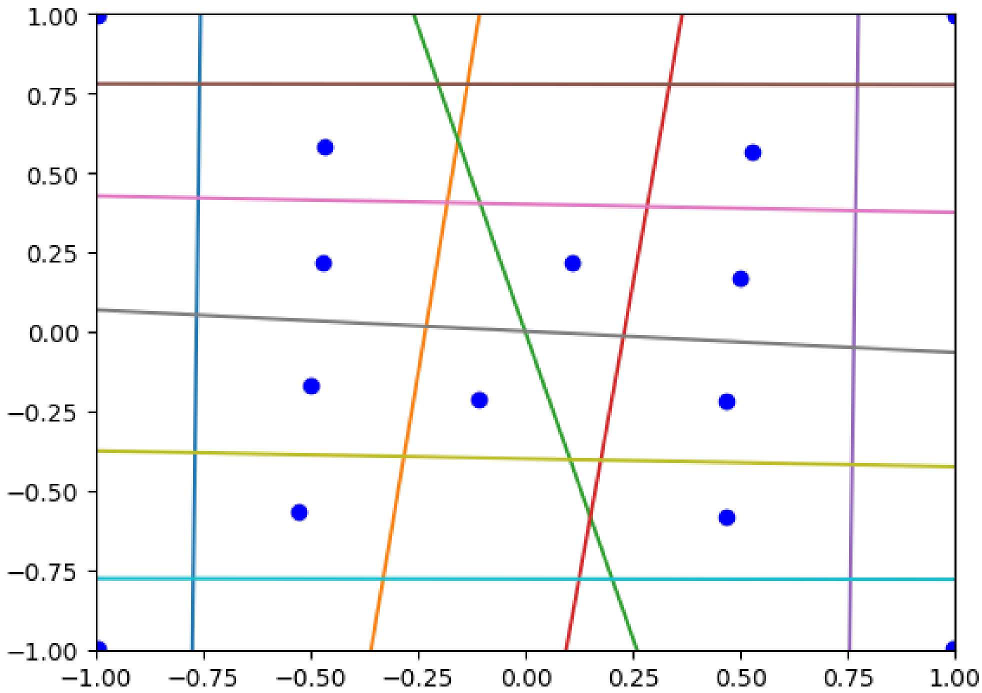
4.

Target1 output:



Its original design is a five-pointed star, although it is somewhat distorted and out of shape, it can be seen that it is a five-pointed star

Target2 output:



It can be seen that this is a capital N, which is the first letter of my English name, so I designed it like this. In the process of drawing, I noticed that the points of the four vertices are very important to prevent distortion of the image. In the end, this picture is so clear and easy to understand that I feel very fulfilled.