

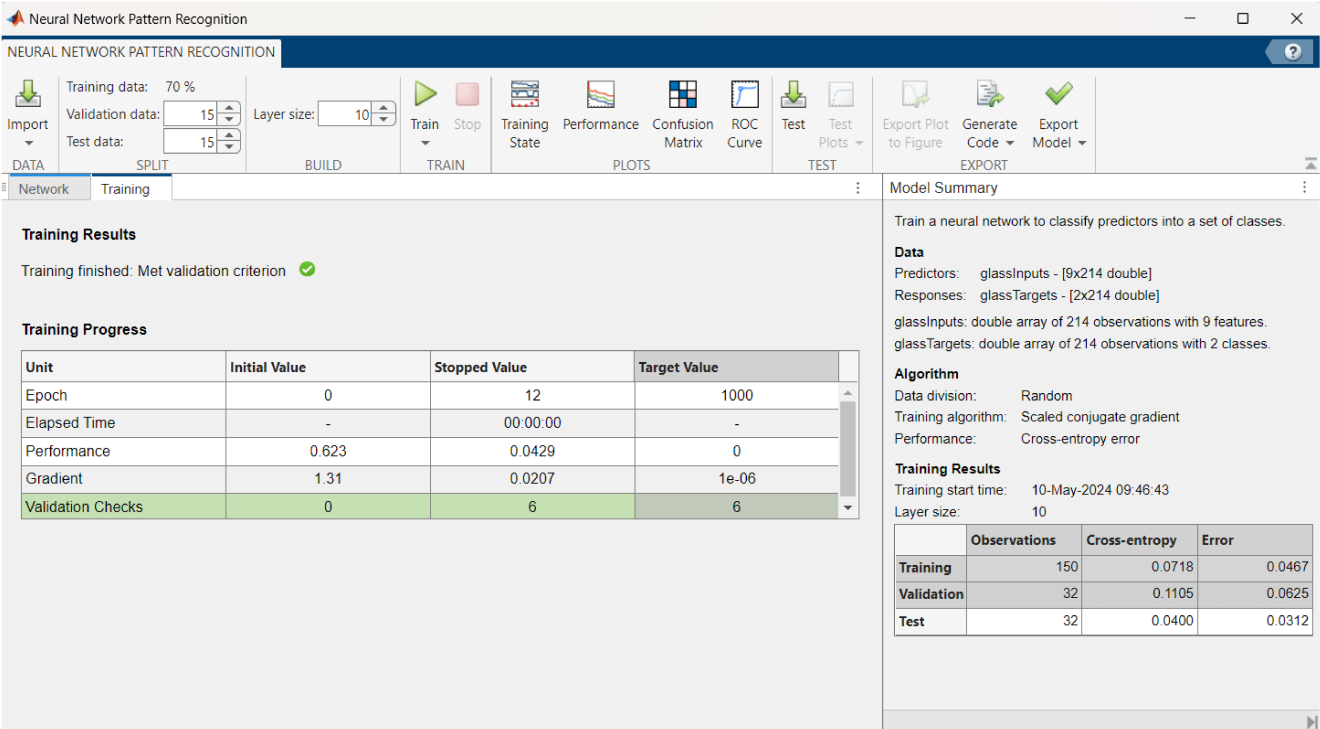
Neural-Network

Created time : 2024/5/10 09:41

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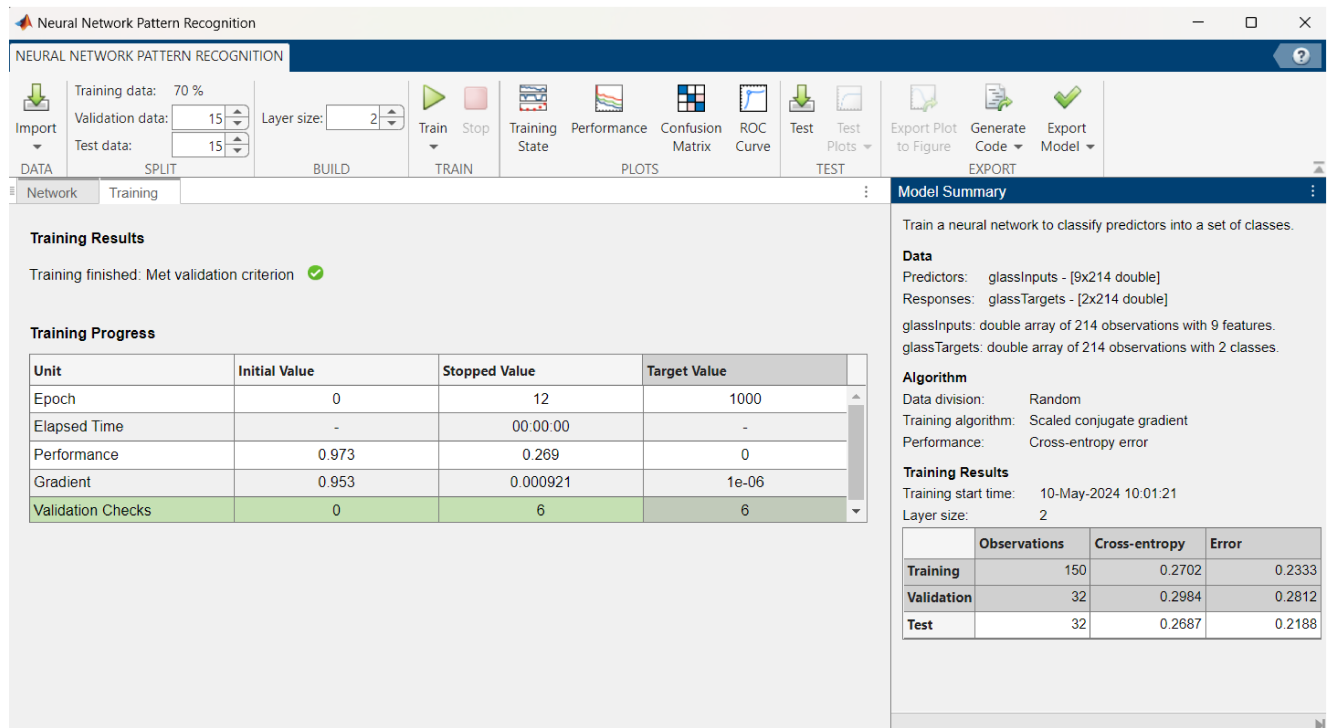
Practice

```
% nprtool
I = imread('./screenshot/neural_network_practice_1.png');
imshow(I)
```



Exercise-1

```
% nprtool
I = imread('./screenshot/neural_network_exercise_1.png');
imshow(I)
```



% 減少 layer size => loss error increase

Exercise-2

Load data

1. sepal length in cm
2. sepal width in cm
3. petal length in cm
4. petal width in cm
5. class:
 - Iris Setosa
 - Iris Versicolour
 - Iris Virginica

```
opts = delimitedTextImportOptions("NumVariables", 5);
```

```
% Specify range and delimiter
opts.DataLines = [1, Inf];
```

```

opts.Delimiter = ",";

% Specify column names and types
opts.VariableNames = ["VarName1", "VarName2", "VarName3", "VarName4", "Irissetosa"];
opts.VariableTypes = ["double", "double", "double", "double", "categorical"];

% Specify file level properties
opts.ExtraColumnsRule = "ignore";
opts.EmptyLineRule = "read";

% Specify variable properties
opts = setvaropts(opts, "Irissetosa", "EmptyFieldRule", "auto");

% Import the data
iris =
readtable("C:\Users\User\Desktop\Matlab\Digital_Image_Processing\data\iris\iris.data", opts)

```

iris = 151x5 table

| | VarName1 | VarName2 | VarName3 | VarName4 | Irissetosa |
|----|----------|----------|----------|----------|-------------|
| 1 | 5.1000 | 3.5000 | 1.4000 | 0.2000 | Iris-setosa |
| 2 | 4.9000 | 3 | 1.4000 | 0.2000 | Iris-setosa |
| 3 | 4.7000 | 3.2000 | 1.3000 | 0.2000 | Iris-setosa |
| 4 | 4.6000 | 3.1000 | 1.5000 | 0.2000 | Iris-setosa |
| 5 | 5 | 3.6000 | 1.4000 | 0.2000 | Iris-setosa |
| 6 | 5.4000 | 3.9000 | 1.7000 | 0.4000 | Iris-setosa |
| 7 | 4.6000 | 3.4000 | 1.4000 | 0.3000 | Iris-setosa |
| 8 | 5 | 3.4000 | 1.5000 | 0.2000 | Iris-setosa |
| 9 | 4.4000 | 2.9000 | 1.4000 | 0.2000 | Iris-setosa |
| 10 | 4.9000 | 3.1000 | 1.5000 | 0.1000 | Iris-setosa |
| 11 | 5.4000 | 3.7000 | 1.5000 | 0.2000 | Iris-setosa |
| 12 | 4.8000 | 3.4000 | 1.6000 | 0.2000 | Iris-setosa |
| 13 | 4.8000 | 3 | 1.4000 | 0.1000 | Iris-setosa |
| 14 | 4.3000 | 3 | 1.1000 | 0.1000 | Iris-setosa |
| 15 | 5.8000 | 4 | 1.2000 | 0.2000 | Iris-setosa |
| 16 | 5.7000 | 4.4000 | 1.5000 | 0.4000 | Iris-setosa |
| 17 | 5.4000 | 3.9000 | 1.3000 | 0.4000 | Iris-setosa |
| 18 | 5.1000 | 3.5000 | 1.4000 | 0.3000 | Iris-setosa |
| 19 | 5.7000 | 3.8000 | 1.7000 | 0.3000 | Iris-setosa |
| 20 | 5.1000 | 3.8000 | 1.5000 | 0.3000 | Iris-setosa |
| 21 | 5.4000 | 3.4000 | 1.7000 | 0.2000 | Iris-setosa |

| | VarName1 | VarName2 | VarName3 | VarName4 | Irissetosa |
|----|----------|----------|----------|----------|-----------------|
| 22 | 5.1000 | 3.7000 | 1.5000 | 0.4000 | Iris-setosa |
| 23 | 4.6000 | 3.6000 | 1 | 0.2000 | Iris-setosa |
| 24 | 5.1000 | 3.3000 | 1.7000 | 0.5000 | Iris-setosa |
| 25 | 4.8000 | 3.4000 | 1.9000 | 0.2000 | Iris-setosa |
| 26 | 5 | 3 | 1.6000 | 0.2000 | Iris-setosa |
| 27 | 5 | 3.4000 | 1.6000 | 0.4000 | Iris-setosa |
| 28 | 5.2000 | 3.5000 | 1.5000 | 0.2000 | Iris-setosa |
| 29 | 5.2000 | 3.4000 | 1.4000 | 0.2000 | Iris-setosa |
| 30 | 4.7000 | 3.2000 | 1.6000 | 0.2000 | Iris-setosa |
| 31 | 4.8000 | 3.1000 | 1.6000 | 0.2000 | Iris-setosa |
| 32 | 5.4000 | 3.4000 | 1.5000 | 0.4000 | Iris-setosa |
| 33 | 5.2000 | 4.1000 | 1.5000 | 0.1000 | Iris-setosa |
| 34 | 5.5000 | 4.2000 | 1.4000 | 0.2000 | Iris-setosa |
| 35 | 4.9000 | 3.1000 | 1.5000 | 0.1000 | Iris-setosa |
| 36 | 5 | 3.2000 | 1.2000 | 0.2000 | Iris-setosa |
| 37 | 5.5000 | 3.5000 | 1.3000 | 0.2000 | Iris-setosa |
| 38 | 4.9000 | 3.1000 | 1.5000 | 0.1000 | Iris-setosa |
| 39 | 4.4000 | 3 | 1.3000 | 0.2000 | Iris-setosa |
| 40 | 5.1000 | 3.4000 | 1.5000 | 0.2000 | Iris-setosa |
| 41 | 5 | 3.5000 | 1.3000 | 0.3000 | Iris-setosa |
| 42 | 4.5000 | 2.3000 | 1.3000 | 0.3000 | Iris-setosa |
| 43 | 4.4000 | 3.2000 | 1.3000 | 0.2000 | Iris-setosa |
| 44 | 5 | 3.5000 | 1.6000 | 0.6000 | Iris-setosa |
| 45 | 5.1000 | 3.8000 | 1.9000 | 0.4000 | Iris-setosa |
| 46 | 4.8000 | 3 | 1.4000 | 0.3000 | Iris-setosa |
| 47 | 5.1000 | 3.8000 | 1.6000 | 0.2000 | Iris-setosa |
| 48 | 4.6000 | 3.2000 | 1.4000 | 0.2000 | Iris-setosa |
| 49 | 5.3000 | 3.7000 | 1.5000 | 0.2000 | Iris-setosa |
| 50 | 5 | 3.3000 | 1.4000 | 0.2000 | Iris-setosa |
| 51 | 7 | 3.2000 | 4.7000 | 1.4000 | Iris-versicolor |
| 52 | 6.4000 | 3.2000 | 4.5000 | 1.5000 | Iris-versicolor |
| 53 | 6.9000 | 3.1000 | 4.9000 | 1.5000 | Iris-versicolor |
| 54 | 5.5000 | 2.3000 | 4 | 1.3000 | Iris-versicolor |

| | VarName1 | VarName2 | VarName3 | VarName4 | Irissetosa |
|----|----------|----------|----------|----------|-----------------|
| 55 | 6.5000 | 2.8000 | 4.6000 | 1.5000 | Iris-versicolor |
| 56 | 5.7000 | 2.8000 | 4.5000 | 1.3000 | Iris-versicolor |
| 57 | 6.3000 | 3.3000 | 4.7000 | 1.6000 | Iris-versicolor |
| 58 | 4.9000 | 2.4000 | 3.3000 | 1 | Iris-versicolor |
| 59 | 6.6000 | 2.9000 | 4.6000 | 1.3000 | Iris-versicolor |
| 60 | 5.2000 | 2.7000 | 3.9000 | 1.4000 | Iris-versicolor |
| 61 | 5 | 2 | 3.5000 | 1 | Iris-versicolor |
| 62 | 5.9000 | 3 | 4.2000 | 1.5000 | Iris-versicolor |
| 63 | 6 | 2.2000 | 4 | 1 | Iris-versicolor |
| 64 | 6.1000 | 2.9000 | 4.7000 | 1.4000 | Iris-versicolor |
| 65 | 5.6000 | 2.9000 | 3.6000 | 1.3000 | Iris-versicolor |
| 66 | 6.7000 | 3.1000 | 4.4000 | 1.4000 | Iris-versicolor |
| 67 | 5.6000 | 3 | 4.5000 | 1.5000 | Iris-versicolor |
| 68 | 5.8000 | 2.7000 | 4.1000 | 1 | Iris-versicolor |
| 69 | 6.2000 | 2.2000 | 4.5000 | 1.5000 | Iris-versicolor |
| 70 | 5.6000 | 2.5000 | 3.9000 | 1.1000 | Iris-versicolor |
| 71 | 5.9000 | 3.2000 | 4.8000 | 1.8000 | Iris-versicolor |
| 72 | 6.1000 | 2.8000 | 4 | 1.3000 | Iris-versicolor |
| 73 | 6.3000 | 2.5000 | 4.9000 | 1.5000 | Iris-versicolor |
| 74 | 6.1000 | 2.8000 | 4.7000 | 1.2000 | Iris-versicolor |
| 75 | 6.4000 | 2.9000 | 4.3000 | 1.3000 | Iris-versicolor |
| 76 | 6.6000 | 3 | 4.4000 | 1.4000 | Iris-versicolor |
| 77 | 6.8000 | 2.8000 | 4.8000 | 1.4000 | Iris-versicolor |
| 78 | 6.7000 | 3 | 5 | 1.7000 | Iris-versicolor |
| 79 | 6 | 2.9000 | 4.5000 | 1.5000 | Iris-versicolor |
| 80 | 5.7000 | 2.6000 | 3.5000 | 1 | Iris-versicolor |
| 81 | 5.5000 | 2.4000 | 3.8000 | 1.1000 | Iris-versicolor |
| 82 | 5.5000 | 2.4000 | 3.7000 | 1 | Iris-versicolor |
| 83 | 5.8000 | 2.7000 | 3.9000 | 1.2000 | Iris-versicolor |
| 84 | 6 | 2.7000 | 5.1000 | 1.6000 | Iris-versicolor |
| 85 | 5.4000 | 3 | 4.5000 | 1.5000 | Iris-versicolor |
| 86 | 6 | 3.4000 | 4.5000 | 1.6000 | Iris-versicolor |
| 87 | 6.7000 | 3.1000 | 4.7000 | 1.5000 | Iris-versicolor |

| | VarName1 | VarName2 | VarName3 | VarName4 | Irissetosa |
|-----|----------|----------|----------|----------|-----------------|
| 88 | 6.3000 | 2.3000 | 4.4000 | 1.3000 | Iris-versicolor |
| 89 | 5.6000 | 3 | 4.1000 | 1.3000 | Iris-versicolor |
| 90 | 5.5000 | 2.5000 | 4 | 1.3000 | Iris-versicolor |
| 91 | 5.5000 | 2.6000 | 4.4000 | 1.2000 | Iris-versicolor |
| 92 | 6.1000 | 3 | 4.6000 | 1.4000 | Iris-versicolor |
| 93 | 5.8000 | 2.6000 | 4 | 1.2000 | Iris-versicolor |
| 94 | 5 | 2.3000 | 3.3000 | 1 | Iris-versicolor |
| 95 | 5.6000 | 2.7000 | 4.2000 | 1.3000 | Iris-versicolor |
| 96 | 5.7000 | 3 | 4.2000 | 1.2000 | Iris-versicolor |
| 97 | 5.7000 | 2.9000 | 4.2000 | 1.3000 | Iris-versicolor |
| 98 | 6.2000 | 2.9000 | 4.3000 | 1.3000 | Iris-versicolor |
| 99 | 5.1000 | 2.5000 | 3 | 1.1000 | Iris-versicolor |
| 100 | 5.7000 | 2.8000 | 4.1000 | 1.3000 | Iris-versicolor |

⋮

Preprocessing

```
data = [ table2array(iris(:,1:4)) double(table2array(iris(:,5))) ];
```

```
% Fix data errors
```

```
data(35, :) = double([4.9 3.1 1.5 0.2 1.0]);
```

```
data(38, :) = double([4.9 3.6 1.4 0.1 1.0]);
```

```
data = rmmissing(data);
```

```
% features
```

```
predicator = data(:, 1:4)';
```

```
% target
```

```
response = data(:, 5)';
```

```
% one-hot encoding
```

```
R = zeros(3, size(response, 2));
```

```
for i=1:3
```

```
R(i, response == i) = 1;
```

```
end
```

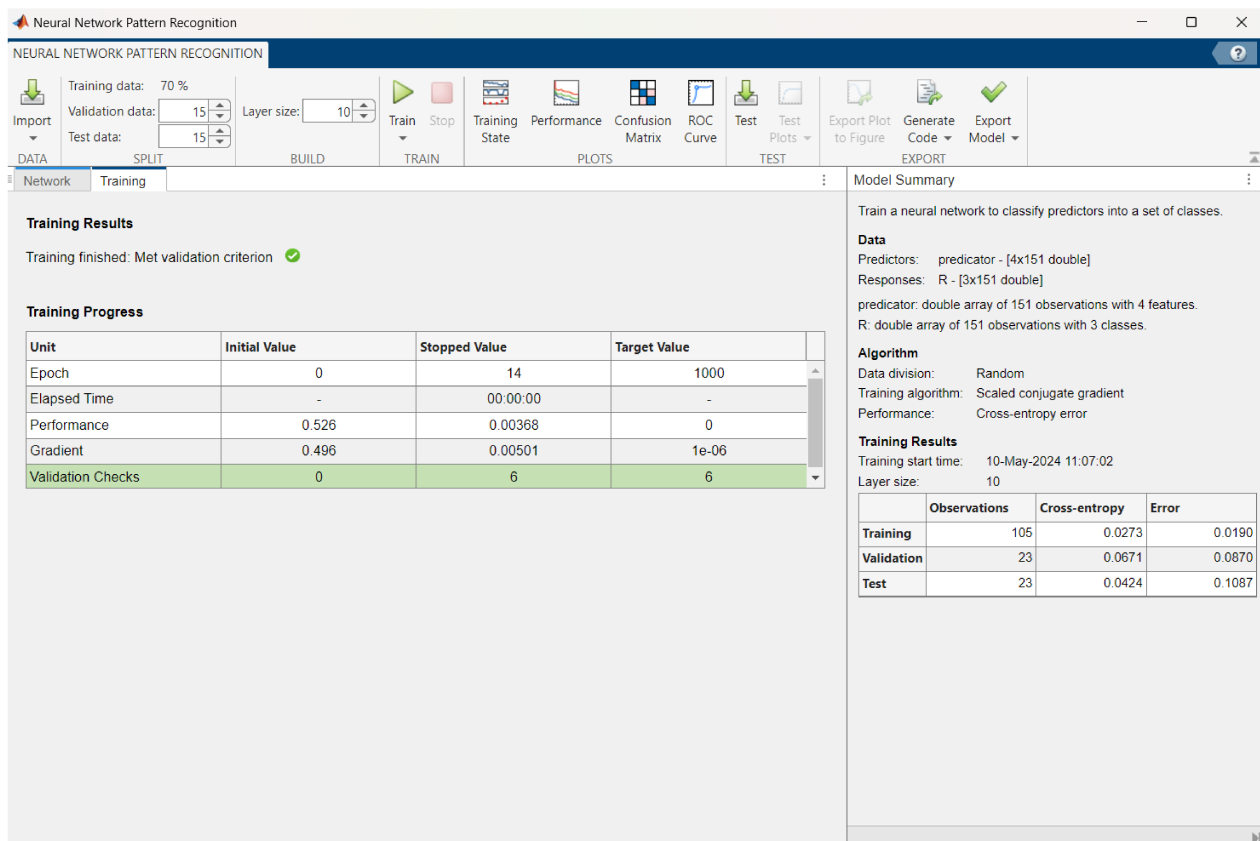
Training

```
% nprtool
```

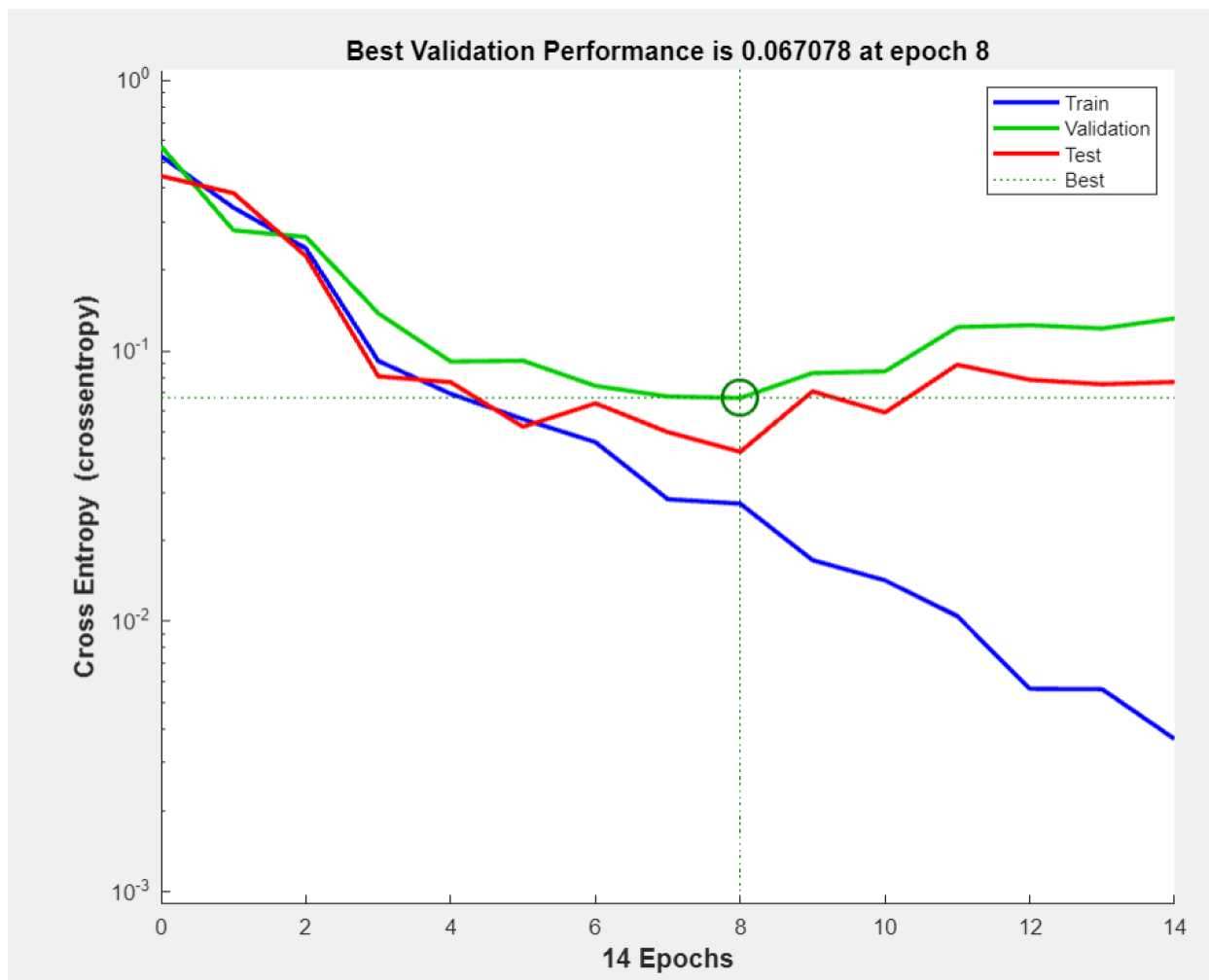
```
training_img = imread('./screenshot/neural_network_exercise_2.png');
```

```
performance_img = imread('./screenshot/neural_network_exercise_2_2.png');
```

```
imshow(training_img)
```



```
imshow(performance_img)
```



Gradient Descent

```
[X, Y] = meshgrid(-10:10, -10:10);
L = (X - 2).^2 + (Y - 3).^2;
mesh(X, Y, L);
xlabel('x'), ylabel('y'), zlabel('L')
```

Initial point

```
hold on
x0 = -10;
y0 = -10;
L0 = (x0 - 2).^2 + (y0 - 3).^2;
plot3(x0, y0, L0, 'or')
hold off

% dL/dx = 2(x-2), dL/dy = 2(y-3)
```



```
dx = 2 * (x0 - 2);  
dy = 2 * (y0 - 3);
```

100 iteration with learning rate

```
lr = 0.05;  
  
hold on  
  
x = zeros(100);  
y = zeros(100);  
  
x(1) = -10;  
y(1) = -10;  
L(1) = (x(1) - 2).^2 + (y(1) - 3).^2;  
plot3(x(1), y(1), L(1), 'or')  
  
for i = 2:100  
    dx = 2 * (x(i - 1) - 2);  
    dy = 2 * (y(i - 1) - 3);  
    x(i) = x(i - 1) - dx * lr;  
    y(i) = y(i - 1) - dy * lr;  
    L(i) = (x(i) - 2).^2 + (y(i) - 3).^2;  
    plot3(x(i), y(i), L(i), 'or')  
end  
  
hold off  
  
view([20 55])
```

