

# Homework 5

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March 8, 2022

## 1 Theory

$$g(z) = \frac{e^z - e^{-z}}{e^z + e^{-z}}$$

$$\frac{\partial g(z)}{\partial z} = \frac{(e^z + e^{-z})(e^z + e^{-z})}{(e^z + e^{-z})^2} - \frac{(e^z - e^{-z})(e^z - e^{-z})}{(e^z + e^{-z})^2}$$

$$\frac{\partial g(z)}{\partial z} = \frac{(e^z + e^{-z})^2 - (e^z - e^{-z})^2}{(e^z + e^{-z})^2}$$

$$\frac{\partial g(z)}{\partial z} = 1 - \left( \frac{e^z - e^{-z}}{e^z + e^{-z}} \right)^2$$

$$\frac{\partial g(z)}{\partial z} = 1 - g(z)^2$$

## 2 Logistical Regression

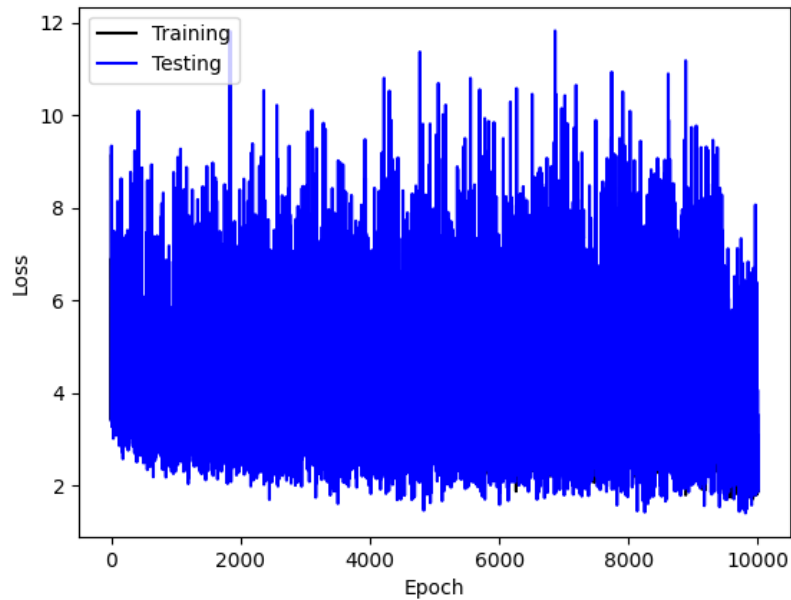


Figure 1: Logistical Regression

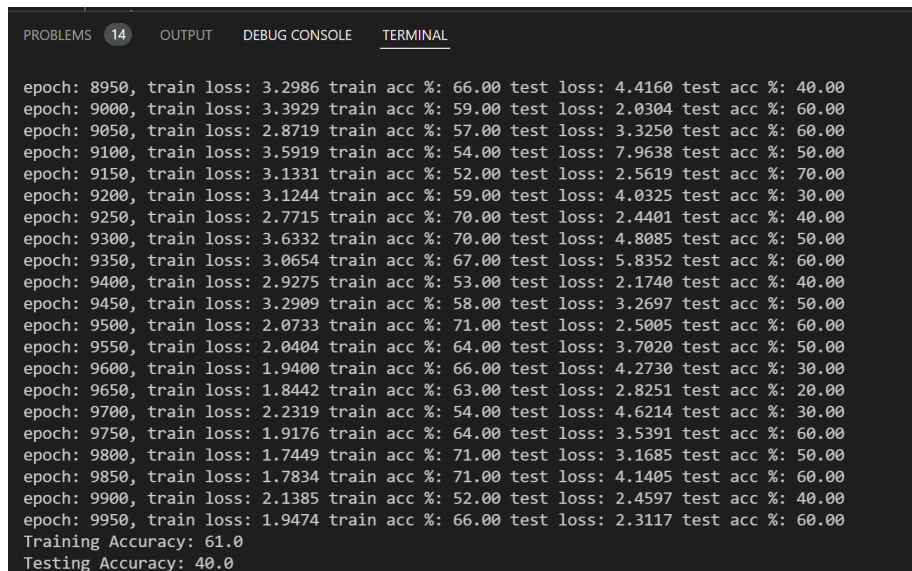


Figure 2: Results

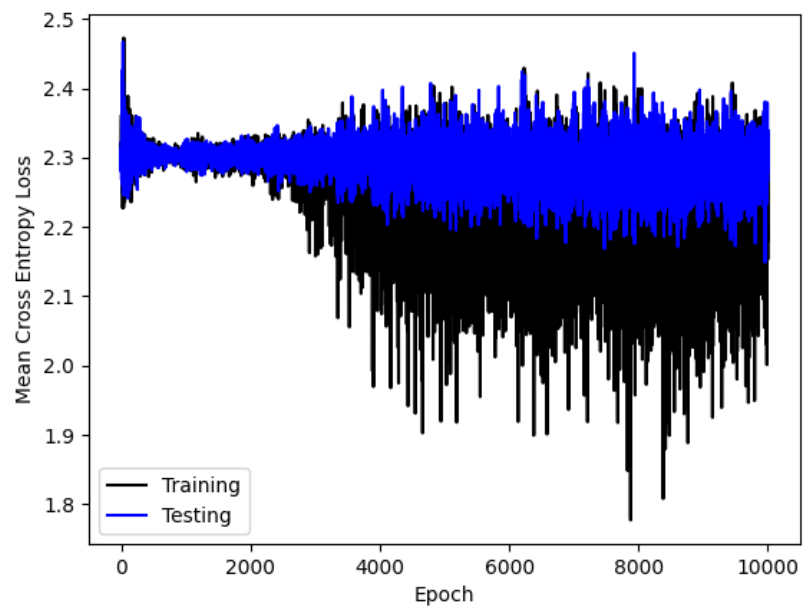


Figure 3: Results

### 3 ANN

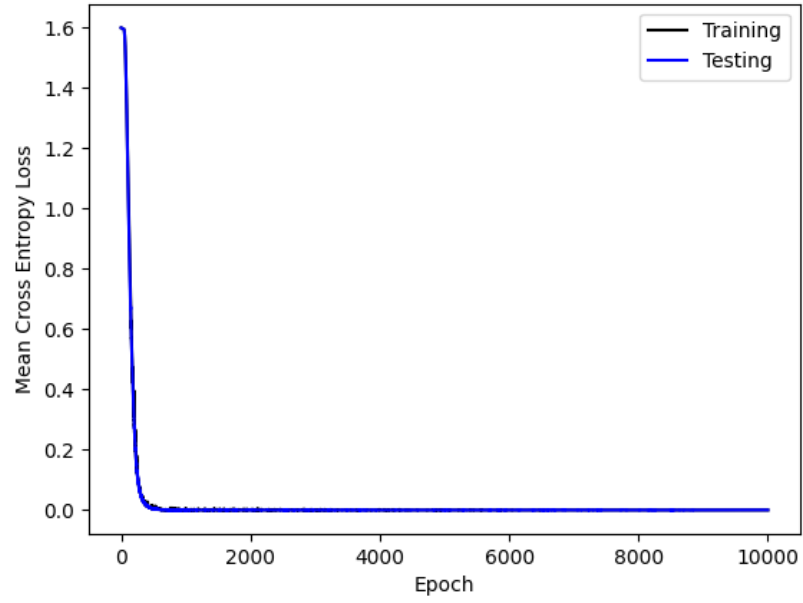


Figure 4: Results

## 4 MLP

1. Architecture 1: [IL, FC1, RL, FC2, SIG, SQ]
2. Architecture 2: [IL, FC1, LIN, FC2, TAN, SQ]
3. Architecture 3: [IL, FC1, FC2, FC3, FC4, SM, CE]

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PROBLEMS OUTPUT DEBUG CONSOLE TERMINAL

epoch: 8200, train loss: 0.0000 train acc %: 10.00 test loss: 0.0004 test acc %: 0.00
epoch: 8300, train loss: 0.0001 train acc %: 0.00 test loss: 0.0000 test acc %: 20.00
epoch: 8400, train loss: 0.0000 train acc %: 10.00 test loss: 0.0000 test acc %: 20.00
epoch: 8500, train loss: 0.0000 train acc %: 0.00 test loss: 0.0000 test acc %: 10.00
epoch: 8600, train loss: 0.0000 train acc %: 0.00 test loss: 0.0000 test acc %: 10.00
epoch: 8700, train loss: 0.0000 train acc %: 0.00 test loss: 0.0002 test acc %: 0.00
epoch: 8800, train loss: 0.0000 train acc %: 10.00 test loss: 0.0000 test acc %: 0.00
epoch: 8900, train loss: 0.0000 train acc %: 20.00 test loss: 0.0000 test acc %: 10.00
epoch: 9000, train loss: 0.0000 train acc %: 10.00 test loss: 0.0000 test acc %: 20.00
epoch: 9100, train loss: 0.0000 train acc %: 20.00 test loss: 0.0000 test acc %: 10.00
epoch: 9200, train loss: 0.0000 train acc %: 0.00 test loss: 0.0000 test acc %: 20.00
epoch: 9300, train loss: 0.0000 train acc %: 0.00 test loss: 0.0000 test acc %: 10.00
epoch: 9400, train loss: 0.0000 train acc %: 10.00 test loss: 0.0000 test acc %: 0.00
epoch: 9500, train loss: 0.0000 train acc %: 20.00 test loss: 0.0000 test acc %: 0.00
epoch: 9600, train loss: 0.0000 train acc %: 0.00 test loss: 0.0000 test acc %: 10.00
epoch: 9700, train loss: 0.0000 train acc %: 0.00 test loss: 0.0000 test acc %: 20.00
epoch: 9800, train loss: 0.0000 train acc %: 10.00 test loss: 0.0000 test acc %: 20.00
epoch: 9900, train loss: 0.0000 train acc %: 10.00 test loss: 0.0000 test acc %: 10.00
Training Accuracy: 10.0
Testing Accuracy: 10.0
```

Figure 5: Results

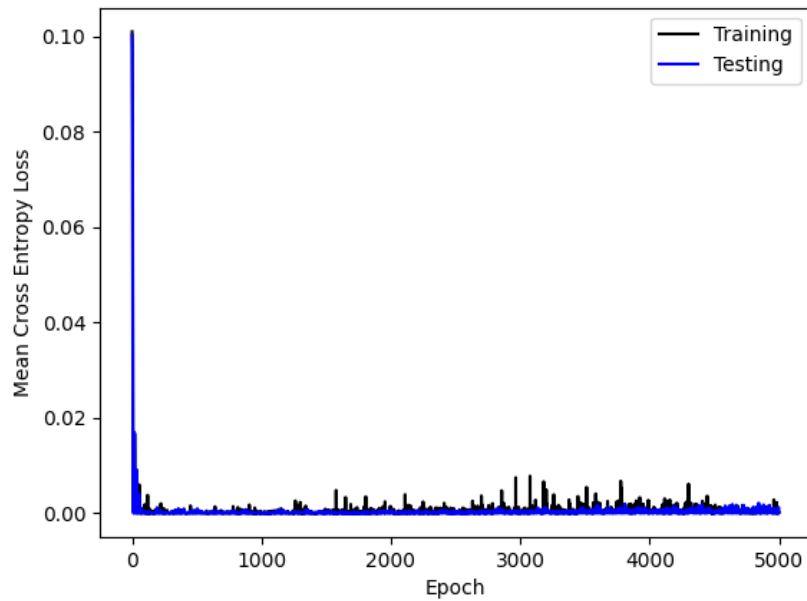


Figure 6: Results

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PROBLEMS OUTPUT DEBUG CONSOLE TERMINAL

epoch: 3200, train loss: 0.0006 train acc %: 60.00 test loss: 0.0006 test acc %: 30.00
epoch: 3300, train loss: 0.0005 train acc %: 40.00 test loss: 0.0001 test acc %: 20.00
epoch: 3400, train loss: 0.0001 train acc %: 10.00 test loss: 0.0001 test acc %: 50.00
epoch: 3500, train loss: 0.0003 train acc %: 20.00 test loss: 0.0006 test acc %: 60.00
epoch: 3600, train loss: 0.0005 train acc %: 30.00 test loss: 0.0004 test acc %: 30.00
epoch: 3700, train loss: 0.0005 train acc %: 20.00 test loss: 0.0004 test acc %: 30.00
epoch: 3800, train loss: 0.0001 train acc %: 20.00 test loss: 0.0003 test acc %: 20.00
epoch: 3900, train loss: 0.0008 train acc %: 20.00 test loss: 0.0011 test acc %: 40.00
epoch: 4000, train loss: 0.0006 train acc %: 20.00 test loss: 0.0004 test acc %: 40.00
epoch: 4100, train loss: 0.0018 train acc %: 60.00 test loss: 0.0001 test acc %: 20.00
epoch: 4200, train loss: 0.0008 train acc %: 30.00 test loss: 0.0006 test acc %: 10.00
epoch: 4300, train loss: 0.0002 train acc %: 50.00 test loss: 0.0002 test acc %: 60.00
epoch: 4400, train loss: 0.0005 train acc %: 30.00 test loss: 0.0002 test acc %: 30.00
epoch: 4500, train loss: 0.0001 train acc %: 60.00 test loss: 0.0003 test acc %: 30.00
epoch: 4600, train loss: 0.0006 train acc %: 50.00 test loss: 0.0007 test acc %: 30.00
epoch: 4700, train loss: 0.0002 train acc %: 60.00 test loss: 0.0000 test acc %: 10.00
epoch: 4800, train loss: 0.0002 train acc %: 40.00 test loss: 0.0002 test acc %: 30.00
epoch: 4900, train loss: 0.0001 train acc %: 10.00 test loss: 0.0001 test acc %: 40.00
Training Accuracy: 50.0
Testing Accuracy: 10.0
```

Figure 7: Results

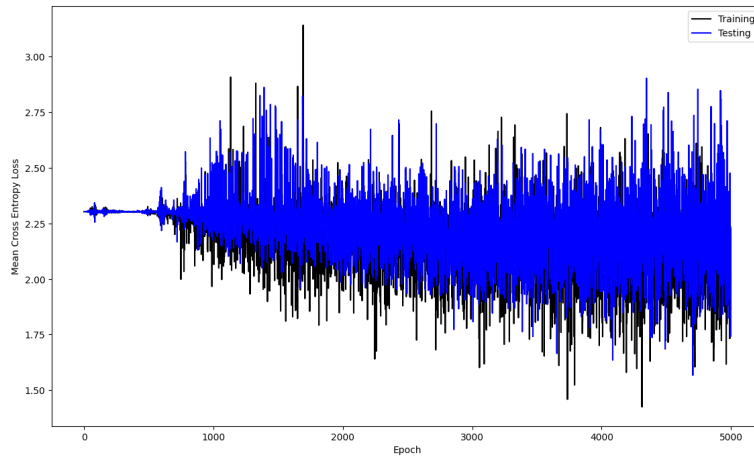


Figure 8: Results

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PROBLEMS  OUTPUT  DEBUG CONSOLE  TERMINAL

epoch: 3200, train loss: 2.0461 train acc %: 30.00 test loss: 2.4324 test acc %: 10.00
epoch: 3300, train loss: 2.2461 train acc %: 0.00 test loss: 2.0221 test acc %: 30.00
epoch: 3400, train loss: 2.1247 train acc %: 20.00 test loss: 1.9519 test acc %: 30.00
epoch: 3500, train loss: 1.9889 train acc %: 20.00 test loss: 2.1370 test acc %: 10.00
epoch: 3600, train loss: 2.1616 train acc %: 10.00 test loss: 2.3830 test acc %: 0.00
epoch: 3700, train loss: 1.9369 train acc %: 50.00 test loss: 1.9610 test acc %: 30.00
epoch: 3800, train loss: 2.1202 train acc %: 10.00 test loss: 2.2655 test acc %: 10.00
epoch: 3900, train loss: 2.1484 train acc %: 20.00 test loss: 1.9355 test acc %: 10.00
epoch: 4000, train loss: 2.5558 train acc %: 10.00 test loss: 2.6044 test acc %: 0.00
epoch: 4100, train loss: 1.9340 train acc %: 20.00 test loss: 2.0901 test acc %: 30.00
epoch: 4200, train loss: 2.4112 train acc %: 0.00 test loss: 2.2629 test acc %: 10.00
epoch: 4300, train loss: 2.2649 train acc %: 0.00 test loss: 2.4107 test acc %: 20.00
epoch: 4400, train loss: 2.0734 train acc %: 20.00 test loss: 2.2567 test acc %: 20.00
epoch: 4500, train loss: 1.9924 train acc %: 20.00 test loss: 2.1032 test acc %: 20.00
epoch: 4600, train loss: 1.8657 train acc %: 30.00 test loss: 1.9937 test acc %: 30.00
epoch: 4700, train loss: 2.1422 train acc %: 0.00 test loss: 2.1435 test acc %: 10.00
epoch: 4800, train loss: 2.2656 train acc %: 10.00 test loss: 2.2732 test acc %: 10.00
epoch: 4900, train loss: 2.1027 train acc %: 20.00 test loss: 2.2359 test acc %: 10.00
Training Accuracy: 30.0
Testing Accuracy: 10.0
```

Figure 9: Results