Binary classification with neural networks

In this experiment, we perform binary classification with neural networks. The dataset we used is the ‘animals’ dataset provided by our lecturer.

1. Data pre-processing

1.1 Data Loading

After loading the data, we need to convert feature1 and feature2 from ‘str’ to ‘float’ because ‘genfromtxt’ will load all data as ‘str’ datatype.

1.2 One-hot encoding and Min-max normalization

We then conduct min-max normalization on two features and encode the target variable using one-hot encoding.

1.3 Target variable distribution

From Fig.1, we can see that the boundary between ‘Dog’ and ‘Cat’ categories is blurry. Two sets have a relatively large intersection area. Therefore, the classification results will be affected.

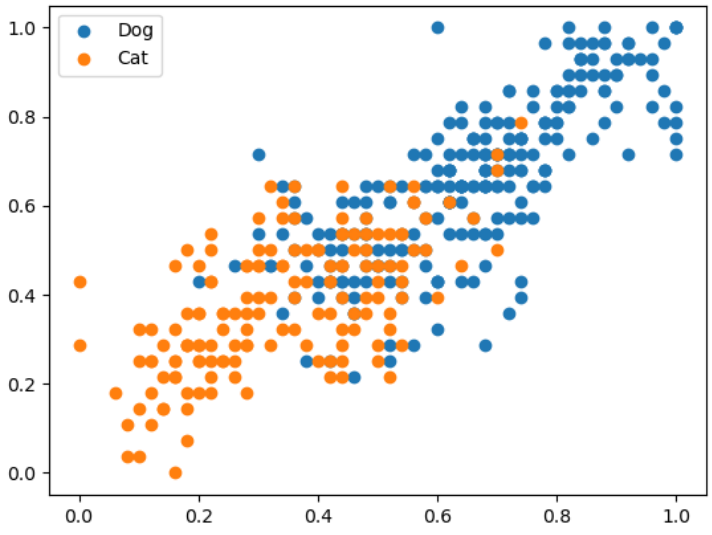

Figure 1. Target variable distribution.

2. Build model

2.1 Model structure

```
AnimalClassifier(
  (lin1): Linear(in_features=2, out_features=10, bias=True)
  (relu1): ReLU()
  (lin2): Linear(in_features=10, out_features=5, bias=True)
  (relu2): ReLU()
  (lin3): Linear(in_features=5, out_features=1, bias=True)
  (sigmoid): Sigmoid()
  (dropout): Dropout(p=0.1, inplace=False)
)
```

Figure 2. Model structure.

2.2 Hyper-parameters

Optimizer	Adam
Learning rate	0.001
Criterion	Binary cross entropy
Random split ratio	0.8 (80% data for training)
Epoch number	60

Table 1. Hyper-parameters for the training process.

3. Training process

3.1 Training loss and accuracy

As we can see in Fig.3, training loss decreases as iterations increase, demonstrating the effectiveness of our training process. Furthermore, the accuracy of each iteration increases during the training process. However, the training process is unstable. This is because the dataset is small, thus, containing more biases that affect the convergence of the neural networks.

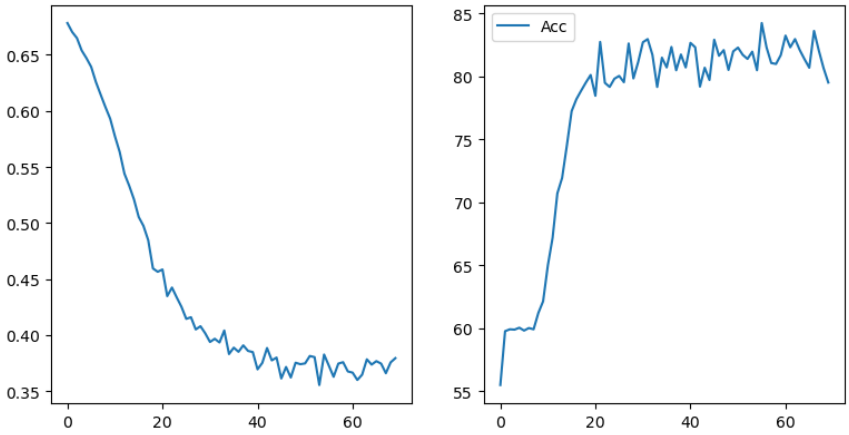

Figure 3. Training loss (left) and accuracy (right).

3.2 Training loss and accuracy values

Final training loss: 0.377

Final training accuracy: 81.1%

4. Testing process

Final testing loss: 0.335

Final testing accuracy: 82.6%

5. Conclusion

In this experiment, we conduct binary classification with neural networks. The experiment results demonstrate the effectiveness of our model. As we listed above, the final testing accuracy is 82.6%, which is way better than random guessing. However, this is still an unsatisfiable result for neural networks models due to the small scale of the dataset and the internal correlation between the two categories. Further exploration will be focused on data cleaning and dataset enhancement methods.