Report: Assignment 2
COMP 8740: Neural Networks
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September 23, 2021

Introduction

In deep neural network, choosing the right hyperparameters e.g. number of layers, learning rate, optimizers etc. is not trivial and can be tuned on trial and error basis. But given a data, if we understand the type of data and the problem to solve with that data, then this tuning becomes much predictable. In this assignment, I will explore these hyperparameters such as number of layers, optimizers, batch size, etc. and some other factors such as feature space or number of kernels on two different datasets - Cifer-10 and 15-Scene.

Problem-1

Experiments

I have experimented with batch size 32, 64, and 128. As the feature space does not change after convolution layer, I have used *same* padding in each convolution layer with *RELU* activation. In total, I ran 100 epochs with batch normalization after each activation. I did the experiment with and without regularizer to see the effect of it on model.

Evaluation

(a) Batch size: 32

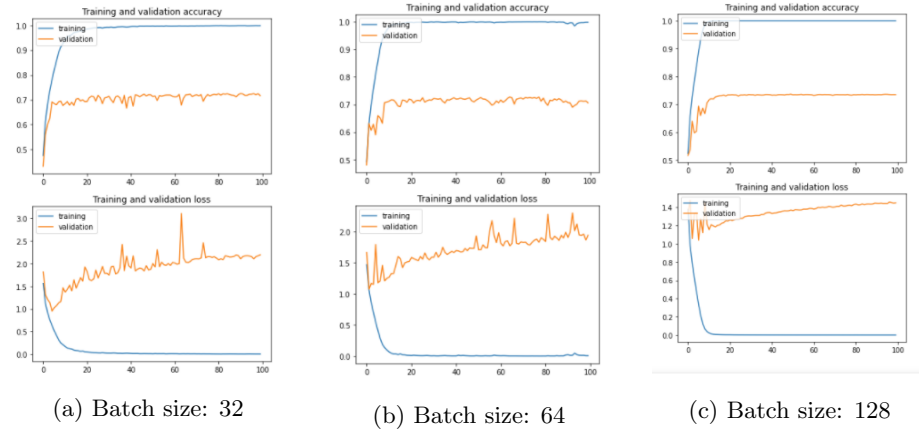(b) Batch size: 64

(c) Batch size: 128

Figure 1: Comparison of different batch sizes

As we can see the loss for validation set is increasing for all batch sizes which is not expected and means the model is overfitted. In case of accuracy, the model performs best (73% accuracy) in validation set for batch size 128.

But the training accuracy is 1, which also indicates the overfitting problem in the model that happened for not using any regularizer.
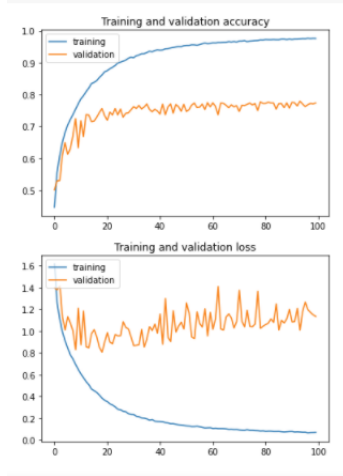

Figure 2: Batch size: 128 (with Dropout regularizer)

After adding dropout regularizer with 0.25 probability with batch size 128, we see the model has improved both in terms of in the validation accuracy and loss.Training accuracy is 98% and validation accuracy is 77%. This means the regularizer is working well on impending the overfitting of the model. The accuracy curve has become more zig-zag shaped which indicates the regularizer is trying to reduce the validation loss in each epoch as it tends to go higher.

Computational Times

As expected, the model training is fastest when batch size was 128 and slowest when batch size was 32. Each epoch took 95 seconds in 32 batch size, 80 seconds in 64 batch size, 6seconds in 128 batch size. I have run these models in Google Colab with GPU. If enough resources are available, then it is better to used large batch size to train faster as long as the generalization error does not increase.

Problem-2

Methodology

We are given 15-Scene dataset where 15 different classes of images are provided. Each image can have different sizes, but each of them has 3 channels (R,G,B). We

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have to implement a CNN in application with normalization, data augmentation, activation function, optimizer etc. to see the classification accuracy. So, given a scene, our target is to classify which class of scene it is among the 15 classes. This is a supervised learning problem as class labels are given.

Before designing the architecture, I pre-processed the data to feed into the DCNN model. The image sizes were different, so I have resized the images and downsized them to 64x64x3 tensor, which means each image is a tensor of square shape in height and width with depth 3 which are the channels. I have used skiimage package for the resizing.

Deep Convolution Neural Network (DCNN) Architecture

Model overview

There are five different criteria that I optimized for designing the DCNN.

- **Data Augmentation**: Data augmentation means we can generate more training data by changing the existing images. There are different parameters for tweaking to do that. However, among them I have used horizontal flipping, horizontal shifting, and vertical shifting. The reason for data augmentation is to make the model familiar with different orientations of the images so that it can be generalized well to the unknown test data and recognize well.

- **Better Initialization method**: *He_uniform* and *Xavier or GlorotUniform* are used. In *He_uniform* initialization, the initial parameters are drawn from a uniform distribution within $[-l, l]$ where $l = sqrt(fan\_in)$ where $fan\_in =$ number of input units in the parameter tensor. On the other hand, *GlorotUniform* draws sample from $[-l, l]$ but the limit l changes to $sqrt(6/(fan\_in + fan\_out))$ where fan_in and fan_out are number of input and output units in the parameter tensor respectively.

- **Activation function- ELU**: ELU or Exponential Linear Unit is similar to RELU. But it has an extra alpha constant which makes the convergence faster. Also in case of negative inputs, the output becomes smoother unlike RELU.

- **Regularization- Dropout**: Inside the model, dropout means a certain number of hidden units will be dropped with a given probability. For example, if the dropout probability is 0.5 that means there is 50% chance of removing the neurons in that epoch while training. It significantly reduces overfitting problem in the network.

- **Batch Normalization**: We do batch normalization to keep the distribution consistent across the layers. This is because each batch is a subset samples from the training data. So, the data distribution may change due

to the internal covariate shift after we apply activation function on each batch. To get rid of this problem and accelerate the convergence, we add batch normalization as a regularizer.

Experiment and Results

For this assignment, I have used the activation function ELU in each case. Dropout regularization with 0.25 and batch normalization is done after activation function is applied on the output of convolution layer. I have run the models with 50 epochs, batch size 256, learning rate 0.01. I have increased the feature space gradually in each convolution layer (32, 32, 64, 64, 64, 128, 128) assuming the pattern identification become complex and require more kernels as the model proceed to classification. At the end, I have used dense layer with 512 units and softmax activation for scene classification task.

Discussion and Comparison

- **Data Augmentation**:

(a) With data augmentation   (b) Without data augmentation
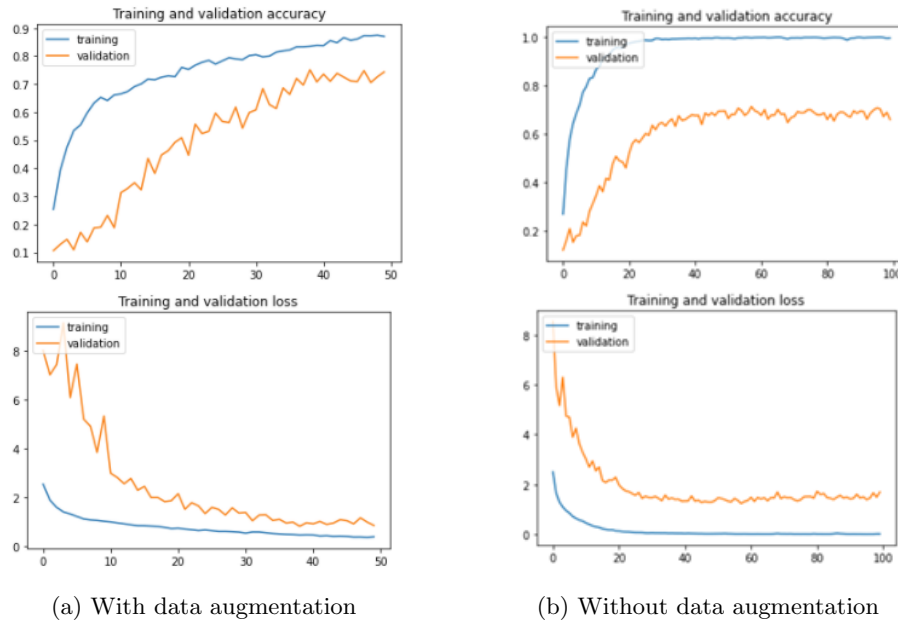
Figure 3: Effect of data augmentation

From the figure 3, we can see, when we are using using data augmentation, then the training and testing loss is gradually becoming smaller. On the other hand, when training data is not augmented, then the testing loss is much higher than the training loss and it remains steady for consecutive

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epochs. So the model is more generalized and scalable when more training data is augmented.

- **Better Initialization method**:

Training and validation accuracy

Training and validation loss

(a) He initializer

(b) Xavier initializer
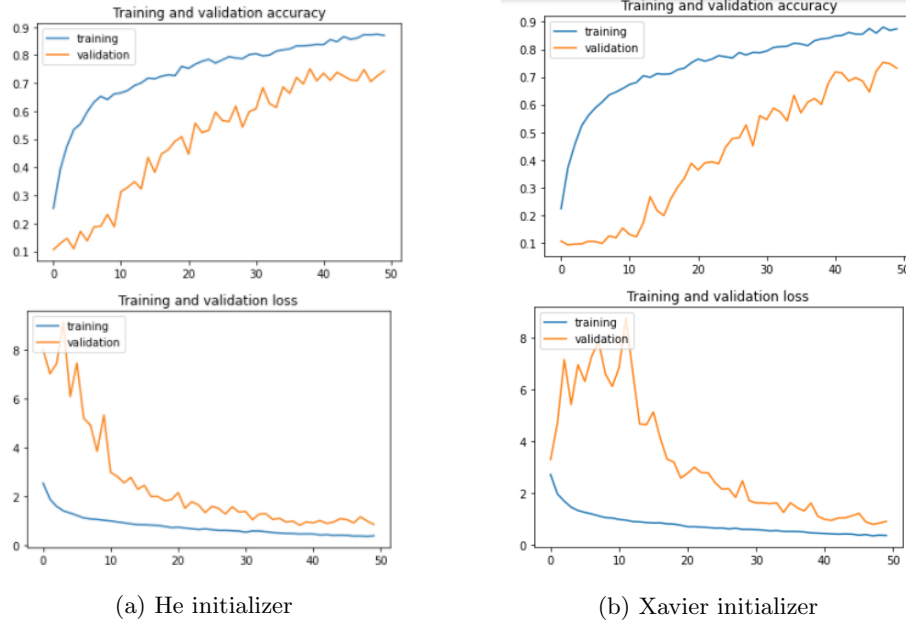
Figure 4: Comparison of different initializers

From figure 4, we see loss is decreasing and accuracy is increasing in both training and testing data. However, in case of *xavier* initializer, in the early epochs, the validation loss curve is very spiky. Also, the accuracy started to get better at later epochs compared to *He* initializer. From this we can say, *He* initializer is helping to converge early and smooth curve than *xavier*.

Optimizer functions

I have experimented with three optimizers as instructed. These are- SGD with momentum, Adam, and RMSProp. Following are the comparison results-

(a) SGD with momentum   (b) Adam optimizer   (c) RMSProp optimizer
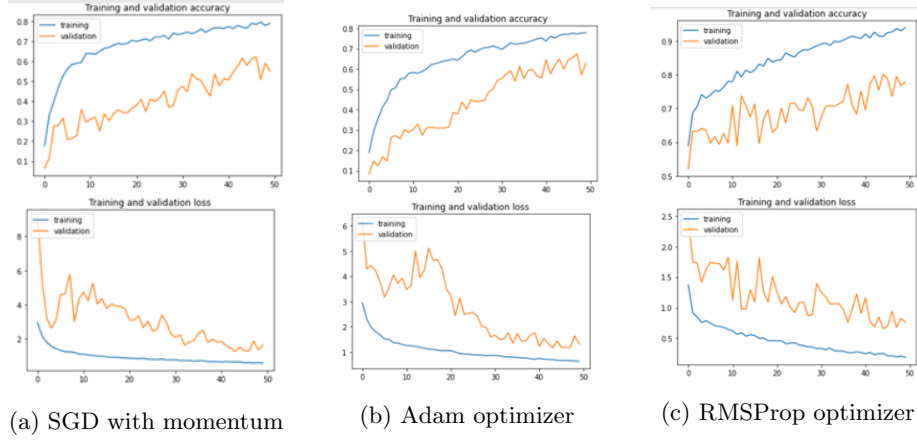
Figure 5: Comparison of different optimizers

In figure 5, it is taking much longer time to get to the minima for loss and maxima for accuracy for all three optimizers in validation set compared to training set. However, still Adam is performing better in loss minimizing even though there is a sudden spike at early epochs. It means, even though it was taking longer time to learn but after certain time, it is converging faster. It is not visible in SGD with momentum or RMSProp optimizer.

Training Logs

In each model no matter what optimizer or initializer I have chosen or not, the validation curves are spiky or less smooth compared to training curves . There might be several reasons, for example- learning rate. If learning rate is large then, each step tends to become bigger but with small learning rate, the learning process becomes very slow.

- **He vs Xavier initializer**: In both cases the best accuracy is 75%, but this is achieved earlier(39 epoch) when He initializer is used compared to Xavier initializer (48 epoch)

- **Data Augmentation**: When data augmentation is used, best validation accuracy achieved is 74.81% at 47 epoch and 87% accuracy in training data. On the other hand, while when training data is not augmented, highest validation accuracy is about 68% but training accuracy is very high 99.97% or about 100%. This means, the model is not generalized well and overfitted when data is not augmented.

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- **Optimizers**: In case of SGD with momentum, if we look closely at the log, the accuracy was very low at the early epochs. However, even though it was improving as epoch increases, validation accuracy did not go beyond 62%.

  For Adam optimizer, the training and validation both accuracy is higher compared to SGD, and in 50 epochs, about 75% validation accuracy has been achieved.

  Last but not the least, RMSProp is doing better in terms of training and validation accuracy (91% and 80% respectively). This means the model is generalized well. But the accuracy and loss both are fluctuating much compared to others.

Conclusion

I have experimented with different hyperparameters such as optimizers, batch size, initialization method, etc. Also, I have observed the effect of data augmentation in generalizing the model. In general, higher batch size makes the training faster but we have to use regularizer to prevent overfitting the model. Also, augmented training data such as flipped, rotated, zoomed data lets the model characterize test/validation data well as adding noise makes the model more robust. Also, Adam is one of the best optimizers and it holds true for 15-scene dataset too. Additionally, changing the kernel weight initializer method from $Xavier$ to He has improved the model performance too. Lastly, I have run the models for 50 epochs in most cases due to time constraint, but running for 100 or more epochs will give better insight in evaluation and comparison among hyperparameters.

Training and Testing logs

- *He* initializer:

Epoch 1/50
13/13 [==============================] — 9s
543ms/step — loss: 2.5525 — accuracy: 0.2536 —
val_loss: 8.0347 — val_accuracy: 0.1062
Epoch 2/50
13/13 [==============================] — 7s
552ms/step — loss: 1.9000 — accuracy: 0.3928 —
val_loss: 7.0349 — val_accuracy: 0.1285
Epoch 3/50
13/13 [==============================] — 7s
547ms/step — loss: 1.5998 — accuracy: 0.4750 —
val_loss: 7.4546 — val_accuracy: 0.1464
Epoch 4/50
13/13 [==============================] — 7s
547ms/step — loss: 1.4158 — accuracy: 0.5342 —
val_loss: 9.1676 — val_accuracy: 0.1092
Epoch 5/50
13/13 [==============================] — 7s
550ms/step — loss: 1.3330 — accuracy: 0.5546 —
val_loss: 6.1029 — val_accuracy: 0.1716
Epoch 6/50
13/13 [==============================] — 7s
528ms/step — loss: 1.2296 — accuracy: 0.5976 —
val_loss: 7.4774 — val_accuracy: 0.1374
Epoch 7/50
13/13 [==============================] — 7s
553ms/step — loss: 1.1265 — accuracy: 0.6327 —
val_loss: 5.2194 — val_accuracy: 0.1872
Epoch 8/50
13/13 [==============================] — 7s
527ms/step — loss: 1.0863 — accuracy: 0.6528 —
val_loss: 4.9275 — val_accuracy: 0.1902
Epoch 9/50
13/13 [==============================] — 7s
547ms/step — loss: 1.0674 — accuracy: 0.6416 —
val_loss: 3.8562 — val_accuracy: 0.2318
Epoch 10/50
13/13 [==============================] — 7s
549ms/step — loss: 1.0317 — accuracy: 0.6617 —
val_loss: 5.3476 — val_accuracy: 0.1880
Epoch 11/50

```
13/13 |=============================| — 7s
    551ms/step − loss: 1.0058 − accuracy: 0.6655 −
    val_loss: 2.9988 − val_accuracy: 0.3135
Epoch 12/50
13/13 |=============================| — 7s
    539ms/step − loss: 0.9656 − accuracy: 0.6741 −
    val_loss: 2.8209 − val_accuracy: 0.3284
Epoch 13/50
13/13 |=============================| — 7s
    547ms/step − loss: 0.9265 − accuracy: 0.6913 −
    val_loss: 2.5706 − val_accuracy: 0.3484
Epoch 14/50
13/13 |=============================| — 7s
    543ms/step − loss: 0.8889 − accuracy: 0.7009 −
    val_loss: 2.7865 − val_accuracy: 0.3232
Epoch 15/50
13/13 |=============================| — 7s
    552ms/step − loss: 0.8507 − accuracy: 0.7184 −
    val_loss: 2.3039 − val_accuracy: 0.4354
Epoch 16/50
13/13 |=============================| — 7s
    529ms/step − loss: 0.8465 − accuracy: 0.7158 −
    val_loss: 2.4600 − val_accuracy: 0.3819
Epoch 17/50
13/13 |=============================| — 7s
    527ms/step − loss: 0.8331 − accuracy: 0.7248 −
    val_loss: 2.0025 − val_accuracy: 0.4473
Epoch 18/50
13/13 |=============================| — 7s
    552ms/step − loss: 0.8190 − accuracy: 0.7295 −
    val_loss: 2.0030 − val_accuracy: 0.4629
Epoch 19/50
13/13 |=============================| — 7s
    550ms/step − loss: 0.7817 − accuracy: 0.7267 −
    val_loss: 1.8392 − val_accuracy: 0.4926
Epoch 20/50
13/13 |=============================| — 7s
    519ms/step − loss: 0.7299 − accuracy: 0.7601 −
    val_loss: 1.8762 − val_accuracy: 0.5089
Epoch 21/50
13/13 |=============================| — 7s
    526ms/step − loss: 0.7461 − accuracy: 0.7528 −
    val_loss: 2.1629 − val_accuracy: 0.4465
Epoch 22/50
13/13 |=============================| — 7s
    531ms/step − loss: 0.7105 − accuracy: 0.7674 −
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```
    val_loss: 1.5253 - val_accuracy: 0.5572
Epoch 23/50
13/13 |==============================| - 7s
    531ms/step - loss: 0.6843 - accuracy: 0.7780 -
    val_loss: 1.7928 - val_accuracy: 0.5238
Epoch 24/50
13/13 |==============================| - 7s
    525ms/step - loss: 0.6517 - accuracy: 0.7850 -
    val_loss: 1.6631 - val_accuracy: 0.5319
Epoch 25/50
13/13 |==============================| - 7s
    524ms/step - loss: 0.6750 - accuracy: 0.7716 -
    val_loss: 1.3493 - val_accuracy: 0.5966
Epoch 26/50
13/13 |==============================| - 7s
    548ms/step - loss: 0.6452 - accuracy: 0.7831 -
    val_loss: 1.6027 - val_accuracy: 0.5669
Epoch 27/50
13/13 |==============================| - 7s
    552ms/step - loss: 0.6170 - accuracy: 0.7942 -
    val_loss: 1.5149 - val_accuracy: 0.5632
Epoch 28/50
13/13 |==============================| - 7s
    551ms/step - loss: 0.6178 - accuracy: 0.7901 -
    val_loss: 1.2922 - val_accuracy: 0.6181
Epoch 29/50
13/13 |==============================| - 7s
    581ms/step - loss: 0.6059 - accuracy: 0.7875 -
    val_loss: 1.5800 - val_accuracy: 0.5431
Epoch 30/50
13/13 |==============================| - 7s
    550ms/step - loss: 0.5881 - accuracy: 0.8018 -
    val_loss: 1.3715 - val_accuracy: 0.5988
Epoch 31/50
13/13 |==============================| - 7s
    526ms/step - loss: 0.5463 - accuracy: 0.8050 -
    val_loss: 1.3937 - val_accuracy: 0.6085
Epoch 32/50
13/13 |==============================| - 7s
    526ms/step - loss: 0.5927 - accuracy: 0.7974 -
    val_loss: 1.0516 - val_accuracy: 0.6842
Epoch 33/50
13/13 |==============================| - 7s
    523ms/step - loss: 0.5914 - accuracy: 0.8003 -
    val_loss: 1.2843 - val_accuracy: 0.6270
Epoch 34/50
```

```
13/13 [==============================] — 7s
    555ms/step — loss: 0.5613 — accuracy: 0.8140 —
    val_loss: 1.2958 — val_accuracy: 0.6129
Epoch 35/50
13/13 [==============================] — 7s
    549ms/step — loss: 0.5314 — accuracy: 0.8187 —
    val_loss: 1.0665 — val_accuracy: 0.6865
Epoch 36/50
13/13 [==============================] — 7s
    581ms/step — loss: 0.5130 — accuracy: 0.8219 —
    val_loss: 1.1093 — val_accuracy: 0.6634
Epoch 37/50
13/13 [==============================] — 7s
    526ms/step — loss: 0.4944 — accuracy: 0.8331 —
    val_loss: 0.9605 — val_accuracy: 0.7207
Epoch 38/50
13/13 [==============================] — 7s
    551ms/step — loss: 0.4873 — accuracy: 0.8334 —
    val_loss: 0.9972 — val_accuracy: 0.6969


Epoch 39/50
13/13 [==============================] — 7s
    527ms/step — loss: 0.4706 — accuracy: 0.8353 —
    val_loss: 0.8271 — val_accuracy: 0.7511
Epoch 40/50
13/13 [==============================] — 7s
    557ms/step — loss: 0.4770 — accuracy: 0.8385 —
    val_loss: 0.9710 — val_accuracy: 0.7080
Epoch 41/50
13/13 [==============================] — 7s
    531ms/step — loss: 0.4728 — accuracy: 0.8375 —
    val_loss: 0.9276 — val_accuracy: 0.7355
Epoch 42/50
13/13 [==============================] — 7s
    553ms/step — loss: 0.4300 — accuracy: 0.8550 —
    val_loss: 1.0247 — val_accuracy: 0.7103
Epoch 43/50
13/13 [==============================] — 7s
    548ms/step — loss: 0.4426 — accuracy: 0.8477 —
    val_loss: 0.9039 — val_accuracy: 0.7385
Epoch 44/50
13/13 [==============================] — 7s
    548ms/step — loss: 0.4144 — accuracy: 0.8659 —
    val_loss: 0.9596 — val_accuracy: 0.7251
Epoch 45/50
```

```
13/13 [==============================] – 7s
    527ms/step – loss: 0.4240 – accuracy: 0.8566 –
    val_loss: 1.0971 – val_accuracy: 0.7117
Epoch 46/50
13/13 [==============================] – 7s
    524ms/step – loss: 0.4114 – accuracy: 0.8608 –
    val_loss: 1.0550 – val_accuracy: 0.7095
Epoch 47/50
13/13 [==============================] – 7s
    525ms/step – loss: 0.3844 – accuracy: 0.8732 –
    val_loss: 0.9276 – val_accuracy: 0.7481
Epoch 48/50
13/13 [==============================] – 7s
    523ms/step – loss: 0.3861 – accuracy: 0.8729 –
    val_loss: 1.1718 – val_accuracy: 0.7058
Epoch 49/50
13/13 [==============================] – 7s
    548ms/step – loss: 0.3719 – accuracy: 0.8748 –
    val_loss: 0.9980 – val_accuracy: 0.7266
Epoch 50/50
13/13 [==============================] – 7s
    546ms/step – loss: 0.3941 – accuracy: 0.8703 –
    val_loss: 0.8615 – val_accuracy: 0.7437
```

- Without Data augmentation:

```
Epoch 1/100
13/13 [==============================] – 39s
    432ms/step – loss: 2.5499 – accuracy: 0.2555 –
    val_loss: 14.3643 – val_accuracy: 0.0602
Epoch 2/100
13/13 [==============================] – 4s
    343ms/step – loss: 1.6574 – accuracy: 0.4677 –
    val_loss: 5.9040 – val_accuracy: 0.2259
Epoch 3/100
13/13 [==============================] – 4s
    343ms/step – loss: 1.2627 – accuracy: 0.5878 –
    val_loss: 6.1247 – val_accuracy: 0.1530
Epoch 4/100
13/13 [==============================] – 4s
    344ms/step – loss: 1.0966 – accuracy: 0.6391 –
    val_loss: 4.5109 – val_accuracy: 0.1909
Epoch 5/100
13/13 [==============================] – 4s
    344ms/step – loss: 0.9888 – accuracy: 0.6770 –
    val_loss: 4.2294 – val_accuracy: 0.2155
```

```
Epoch 6/100
13/13 [==============================] — 4s
    344ms/step — loss: 0.8567 — accuracy: 0.7222 —
    val_loss: 4.1594 — val_accuracy: 0.1954
Epoch 7/100
13/13 [==============================] — 4s
    344ms/step — loss: 0.7473 — accuracy: 0.7579 —
    val_loss: 2.9266 — val_accuracy: 0.3083
Epoch 8/100
13/13 [==============================] — 4s
    343ms/step — loss: 0.6280 — accuracy: 0.7964 —
    val_loss: 3.4475 — val_accuracy: 0.2689
Epoch 9/100
13/13 [==============================] — 4s
    336ms/step — loss: 0.5844 — accuracy: 0.8184 —
    val_loss: 2.5488 — val_accuracy: 0.3247
Epoch 10/100
13/13 [==============================] — 4s
    345ms/step — loss: 0.5325 — accuracy: 0.8324 —
    val_loss: 2.7569 — val_accuracy: 0.3403
Epoch 11/100
13/13 [==============================] — 4s
    337ms/step — loss: 0.4697 — accuracy: 0.8592 —
    val_loss: 2.4857 — val_accuracy: 0.3432
Epoch 12/100
13/13 [==============================] — 4s
    337ms/step — loss: 0.4188 — accuracy: 0.8713 —
    val_loss: 2.1796 — val_accuracy: 0.3900
Epoch 13/100
13/13 [==============================] — 4s
    337ms/step — loss: 0.3653 — accuracy: 0.8984 —
    val_loss: 2.1618 — val_accuracy: 0.4004
Epoch 14/100
13/13 [==============================] — 4s
    345ms/step — loss: 0.3346 — accuracy: 0.9047 —
    val_loss: 2.3126 — val_accuracy: 0.3626
Epoch 15/100
13/13 [==============================] — 4s
    336ms/step — loss: 0.2749 — accuracy: 0.9315 —
    val_loss: 1.9275 — val_accuracy: 0.4539
Epoch 16/100
13/13 [==============================] — 4s
    339ms/step — loss: 0.2333 — accuracy: 0.9442 —
    val_loss: 2.0040 — val_accuracy: 0.4398
Epoch 17/100
13/13 [==============================] — 4s
```

```
          338ms/step − loss: 0.2162 − accuracy: 0.9458 −
     val_loss: 1.9688 − val_accuracy: 0.4591
Epoch 18/100
13/13 |════════════════════════════════════| − 4s
          346ms/step − loss: 0.1853 − accuracy: 0.9538 −
     val_loss: 1.8412 − val_accuracy: 0.5052
Epoch 19/100
13/13 |════════════════════════════════════| − 4s
          345ms/step − loss: 0.1536 − accuracy: 0.9665 −
     val_loss: 1.7197 − val_accuracy: 0.5253
Epoch 20/100
13/13 |════════════════════════════════════| − 4s
          337ms/step − loss: 0.1469 − accuracy: 0.9650 −
     val_loss: 1.6409 − val_accuracy: 0.5386
Epoch 21/100
13/13 |════════════════════════════════════| − 4s
          339ms/step − loss: 0.1259 − accuracy: 0.9771 −
     val_loss: 1.7288 − val_accuracy: 0.5290
Epoch 22/100
13/13 |════════════════════════════════════| − 4s
          337ms/step − loss: 0.1167 − accuracy: 0.9783 −
     val_loss: 1.7565 − val_accuracy: 0.5178
Epoch 23/100
13/13 |════════════════════════════════════| − 4s
          346ms/step − loss: 0.1122 − accuracy: 0.9787 −
     val_loss: 1.4861 − val_accuracy: 0.5862
Epoch 24/100
13/13 |════════════════════════════════════| − 4s
          337ms/step − loss: 0.1039 − accuracy: 0.9806 −
     val_loss: 1.6219 − val_accuracy: 0.5654
Epoch 25/100
13/13 |════════════════════════════════════| − 4s
          347ms/step − loss: 0.0882 − accuracy: 0.9828 −
     val_loss: 1.4805 − val_accuracy: 0.6010
Epoch 26/100
13/13 |════════════════════════════════════| − 4s
          346ms/step − loss: 0.1068 − accuracy: 0.9761 −
     val_loss: 1.5185 − val_accuracy: 0.5892
Epoch 27/100
13/13 |════════════════════════════════════| − 4s
          337ms/step − loss: 0.0764 − accuracy: 0.9876 −
     val_loss: 1.4966 − val_accuracy: 0.6166
Epoch 28/100
13/13 |════════════════════════════════════| − 4s
          337ms/step − loss: 0.0689 − accuracy: 0.9901 −
     val_loss: 1.2986 − val_accuracy: 0.6523
```

```
Epoch 29/100
13/13 [==============================] — 4s
    337ms/step — loss: 0.0755 — accuracy: 0.9831 —
    val_loss: 1.4029 — val_accuracy: 0.6218
Epoch 30/100
13/13 [==============================] — 4s
    348ms/step — loss: 0.0592 — accuracy: 0.9895 —
    val_loss: 1.4390 — val_accuracy: 0.6330
Epoch 31/100
13/13 [==============================] — 4s
    344ms/step — loss: 0.0600 — accuracy: 0.9901 —
    val_loss: 1.3875 — val_accuracy: 0.6404
Epoch 32/100
13/13 [==============================] — 4s
    346ms/step — loss: 0.0487 — accuracy: 0.9927 —
    val_loss: 1.2695 — val_accuracy: 0.6709
Epoch 33/100
13/13 [==============================] — 4s
    346ms/step — loss: 0.0441 — accuracy: 0.9939 —
    val_loss: 1.4121 — val_accuracy: 0.6686
Epoch 34/100
13/13 [==============================] — 4s
    345ms/step — loss: 0.0467 — accuracy: 0.9943 —
    val_loss: 1.3277 — val_accuracy: 0.6649
Epoch 35/100
13/13 [==============================] — 4s
    344ms/step — loss: 0.0614 — accuracy: 0.9885 —
    val_loss: 1.3048 — val_accuracy: 0.6701
Epoch 36/100
13/13 [==============================] — 4s
    345ms/step — loss: 0.0558 — accuracy: 0.9898 —
    val_loss: 1.3031 — val_accuracy: 0.6731
Epoch 37/100
13/13 [==============================] — 4s
    337ms/step — loss: 0.0517 — accuracy: 0.9924 —
    val_loss: 1.3850 — val_accuracy: 0.6449
Epoch 38/100
13/13 [==============================] — 4s
    344ms/step — loss: 0.0393 — accuracy: 0.9946 —
    val_loss: 1.2293 — val_accuracy: 0.6746
Epoch 39/100
13/13 [==============================] — 4s
    345ms/step — loss: 0.0335 — accuracy: 0.9962 —
    val_loss: 1.2127 — val_accuracy: 0.6887
Epoch 40/100
13/13 [==============================] — 4s
```

```
    346ms/step − loss: 0.0317 − accuracy: 0.9965 −
    val_loss: 1.1982 − val_accuracy: 0.6932
Epoch 41/100
13/13 |==============================| − 4s
    337ms/step − loss: 0.0296 − accuracy: 0.9959 −
    val_loss: 1.2031 − val_accuracy: 0.6887
Epoch 42/100
13/13 |==============================| − 4s
    346ms/step − loss: 0.0267 − accuracy: 0.9971 −
    val_loss: 1.1923 − val_accuracy: 0.6947
Epoch 43/100
13/13 |==============================| − 4s
    338ms/step − loss: 0.0298 − accuracy: 0.9959 −
    val_loss: 1.2928 − val_accuracy: 0.6828
Epoch 44/100
13/13 |==============================| − 4s
    346ms/step − loss: 0.0268 − accuracy: 0.9968 −
    val_loss: 1.2673 − val_accuracy: 0.6835
Epoch 45/100
13/13 |==============================| − 4s
    336ms/step − loss: 0.0222 − accuracy: 0.9981 −
    val_loss: 1.2951 − val_accuracy: 0.6768
Epoch 46/100
13/13 |==============================| − 4s
    345ms/step − loss: 0.0234 − accuracy: 0.9978 −
    val_loss: 1.1761 − val_accuracy: 0.6909
Epoch 47/100
13/13 |==============================| − 4s
    337ms/step − loss: 0.0173 − accuracy: 0.9997 −
    val_loss: 1.2871 − val_accuracy: 0.6798
Epoch 48/100
13/13 |==============================| − 4s
    344ms/step − loss: 0.0180 − accuracy: 0.9990 −
    val_loss: 1.3064 − val_accuracy: 0.6835
Epoch 49/100
13/13 |==============================| − 4s
    339ms/step − loss: 0.0172 − accuracy: 0.9981 −
    val_loss: 1.2347 − val_accuracy: 0.6828
Epoch 50/100
13/13 |==============================| − 4s
    337ms/step − loss: 0.0161 − accuracy: 0.9994 −
    val_loss: 1.2746 − val_accuracy: 0.6872
Epoch 51/100
13/13 |==============================| − 4s
    346ms/step − loss: 0.0136 − accuracy: 0.9994 −
    val_loss: 1.2963 − val_accuracy: 0.6835
```

```
Epoch 52/100
13/13 [==============================] — 4s
    345ms/step — loss: 0.0131 — accuracy: 0.9994 —
    val_loss: 1.2528 — val_accuracy: 0.6969
Epoch 53/100
13/13 [==============================] — 4s
    346ms/step — loss: 0.0128 — accuracy: 0.9978 —
    val_loss: 1.2844 — val_accuracy: 0.6865
Epoch 54/100
13/13 [==============================] — 4s
    345ms/step — loss: 0.0161 — accuracy: 0.9978 —
    val_loss: 1.2826 — val_accuracy: 0.6820
Epoch 55/100
13/13 [==============================] — 4s
    337ms/step — loss: 0.0175 — accuracy: 0.9968 —
    val_loss: 1.1757 — val_accuracy: 0.7021
Epoch 56/100
13/13 [==============================] — 4s
    346ms/step — loss: 0.0287 — accuracy: 0.9930 —
    val_loss: 1.3140 — val_accuracy: 0.6694
Epoch 57/100
13/13 [==============================] — 4s
    339ms/step — loss: 0.0252 — accuracy: 0.9952 —
    val_loss: 1.3625 — val_accuracy: 0.6672
Epoch 58/100
13/13 [==============================] — 4s
    347ms/step — loss: 0.0238 — accuracy: 0.9962 —
    val_loss: 1.3226 — val_accuracy: 0.6872
Epoch 59/100
13/13 [==============================] — 4s
    346ms/step — loss: 0.0199 — accuracy: 0.9968 —
    val_loss: 1.2931 — val_accuracy: 0.6954
Epoch 60/100
13/13 [==============================] — 4s
    346ms/step — loss: 0.0181 — accuracy: 0.9975 —
    val_loss: 1.2276 — val_accuracy: 0.6999
Epoch 61/100
13/13 [==============================] — 4s
    345ms/step — loss: 0.0177 — accuracy: 0.9968 —
    val_loss: 1.3586 — val_accuracy: 0.6724
Epoch 62/100
13/13 [==============================] — 4s
    339ms/step — loss: 0.0204 — accuracy: 0.9971 —
    val_loss: 1.4133 — val_accuracy: 0.6865
Epoch 63/100
13/13 [==============================] — 4s
```

```
    345ms/step — loss: 0.0176 — accuracy: 0.9971 —
    val_loss: 1.3403 — val_accuracy: 0.6887
Epoch 64/100
13/13 |==============================| — 4s
    338ms/step — loss: 0.0145 — accuracy: 0.9984 —
    val_loss: 1.3220 — val_accuracy: 0.6961
Epoch 65/100
13/13 |==============================| — 4s
    346ms/step — loss: 0.0123 — accuracy: 0.9994 —
    val_loss: 1.2712 — val_accuracy: 0.7021
Epoch 66/100
13/13 |==============================| — 4s
    345ms/step — loss: 0.0122 — accuracy: 0.9990 —
    val_loss: 1.2799 — val_accuracy: 0.7080
Epoch 67/100
13/13 |==============================| — 4s
    346ms/step — loss: 0.0117 — accuracy: 0.9981 —
    val_loss: 1.3202 — val_accuracy: 0.6947
Epoch 68/100
13/13 |==============================| — 4s
    345ms/step — loss: 0.0112 — accuracy: 0.9994 —
    val_loss: 1.3040 — val_accuracy: 0.6932
Epoch 69/100
13/13 |==============================| — 4s
    338ms/step — loss: 0.0117 — accuracy: 0.9984 —
    val_loss: 1.4505 — val_accuracy: 0.6776
Epoch 70/100
13/13 |==============================| — 4s
    345ms/step — loss: 0.0139 — accuracy: 0.9981 —
    val_loss: 1.3713 — val_accuracy: 0.6865
Epoch 71/100
13/13 |==============================| — 4s
    337ms/step — loss: 0.0277 — accuracy: 0.9936 —
    val_loss: 1.3195 — val_accuracy: 0.6805
Epoch 72/100
13/13 |==============================| — 4s
    336ms/step — loss: 0.0201 — accuracy: 0.9955 —
    val_loss: 1.3781 — val_accuracy: 0.6716
Epoch 73/100
13/13 |==============================| — 4s
    345ms/step — loss: 0.0183 — accuracy: 0.9968 —
    val_loss: 1.3279 — val_accuracy: 0.6939
Epoch 74/100
13/13 |==============================| — 4s
    337ms/step — loss: 0.0237 — accuracy: 0.9955 —
    val_loss: 1.3022 — val_accuracy: 0.6932
```

```
Epoch 75/100
13/13 [==============================] — 4 s
    346ms/step — loss: 0.0163 — accuracy: 0.9975 —
    val_loss: 1.3531 — val_accuracy: 0.6857
Epoch 76/100
13/13 [==============================] — 4 s
    345ms/step — loss: 0.0157 — accuracy: 0.9971 —
    val_loss: 1.3784 — val_accuracy: 0.6961
Epoch 77/100
13/13 [==============================] — 4 s
    346ms/step — loss: 0.0115 — accuracy: 0.9987 —
    val_loss: 1.4041 — val_accuracy: 0.6850
Epoch 78/100
13/13 [==============================] — 4 s
    337ms/step — loss: 0.0074 — accuracy: 0.9994 —
    val_loss: 1.2504 — val_accuracy: 0.7013
Epoch 79/100
13/13 [==============================] — 4 s
    337ms/step — loss: 0.0074 — accuracy: 0.9997 —
    val_loss: 1.3241 — val_accuracy: 0.6969
Epoch 80/100
13/13 [==============================] — 4 s
    337ms/step — loss: 0.0084 — accuracy: 0.9997 —
    val_loss: 1.3055 — val_accuracy: 0.6984
Epoch 81/100
13/13 [==============================] — 4 s
    338ms/step — loss: 0.0075 — accuracy: 0.9994 —
    val_loss: 1.2426 — val_accuracy: 0.7058
Epoch 82/100
13/13 [==============================] — 4 s
    337ms/step — loss: 0.0061 — accuracy: 0.9997 —
    val_loss: 1.2849 — val_accuracy: 0.7006
Epoch 83/100
13/13 [==============================] — 4 s
    338ms/step — loss: 0.0059 — accuracy: 0.9997 —
    val_loss: 1.2846 — val_accuracy: 0.6961
Epoch 84/100
13/13 [==============================] — 4 s
    346ms/step — loss: 0.0065 — accuracy: 0.9990 —
    val_loss: 1.3155 — val_accuracy: 0.6961
Epoch 85/100
13/13 [==============================] — 4 s
    338ms/step — loss: 0.0057 — accuracy: 1.0000 —
    val_loss: 1.3615 — val_accuracy: 0.6857
Epoch 86/100
13/13 [==============================] — 4 s
```

```
    347ms/step − loss: 0.0058 − accuracy: 0.9994 −
    val_loss: 1.2618 − val_accuracy: 0.7036
Epoch 87/100
13/13 |===============================| − 4s
    338ms/step − loss: 0.0056 − accuracy: 0.9997 −
    val_loss: 1.2435 − val_accuracy: 0.7043
Epoch 88/100
13/13 |===============================| − 4s
    338ms/step − loss: 0.0048 − accuracy: 1.0000 −
    val_loss: 1.3092 − val_accuracy: 0.7036
Epoch 89/100
13/13 |===============================| − 4s
    345ms/step − loss: 0.0054 − accuracy: 0.9997 −
    val_loss: 1.3555 − val_accuracy: 0.6961
Epoch 90/100
13/13 |===============================| − 4s
    338ms/step − loss: 0.0047 − accuracy: 0.9997 −
    val_loss: 1.5086 − val_accuracy: 0.6731
Epoch 91/100
13/13 |===============================| − 4s
    344ms/step − loss: 0.0054 − accuracy: 0.9997 −
    val_loss: 1.3630 − val_accuracy: 0.6768
Epoch 92/100
13/13 |===============================| − 4s
    346ms/step − loss: 0.0044 − accuracy: 1.0000 −
    val_loss: 1.3002 − val_accuracy: 0.6939
Epoch 93/100
13/13 |===============================| − 4s
    345ms/step − loss: 0.0034 − accuracy: 1.0000 −
    val_loss: 1.3426 − val_accuracy: 0.6895
Epoch 94/100
13/13 |===============================| − 4s
    345ms/step − loss: 0.0061 − accuracy: 0.9987 −
    val_loss: 1.3680 − val_accuracy: 0.6880
Epoch 95/100
13/13 |===============================| − 4s
    338ms/step − loss: 0.0147 − accuracy: 0.9975 −
    val_loss: 1.4811 − val_accuracy: 0.6709
Epoch 96/100
13/13 |===============================| − 4s
    346ms/step − loss: 0.0126 − accuracy: 0.9978 −
    val_loss: 1.5950 − val_accuracy: 0.6731
Epoch 97/100
13/13 |===============================| − 4s
    346ms/step − loss: 0.0101 − accuracy: 0.9978 −
    val_loss: 1.5072 − val_accuracy: 0.6768
```

```
Epoch 98/100
13/13 |=================================| — 4 s
     346 ms/step — loss: 0.0110 — accuracy: 0.9978 —
     val_loss: 1.3680 — val_accuracy: 0.6909
Epoch 99/100
13/13 |=================================| — 4 s
     337 ms/step — loss: 0.0075 — accuracy: 0.9990 —
     val_loss: 1.3318 — val_accuracy: 0.6969
Epoch 100/100
13/13 |=================================| — 4 s
     345 ms/step — loss: 0.0121 — accuracy: 0.9978 —
     val_loss: 1.3264 — val_accuracy: 0.6991
```

- *Xavier* initializer:

```
Epoch 1/50
13/13 |=================================| — 7 s
     557 ms/step — loss: 2.7176 — accuracy: 0.2236 —
     val_loss: 3.2987 — val_accuracy: 0.1062
Epoch 2/50
13/13 |=================================| — 7 s
     527 ms/step — loss: 1.9712 — accuracy: 0.3718 —
     val_loss: 4.6928 — val_accuracy: 0.0921
Epoch 3/50
13/13 |=================================| — 7 s
     525 ms/step — loss: 1.6948 — accuracy: 0.4552 —
     val_loss: 7.1386 — val_accuracy: 0.0951
Epoch 4/50
13/13 |=================================| — 7 s
     530 ms/step — loss: 1.4632 — accuracy: 0.5234 —
     val_loss: 5.4160 — val_accuracy: 0.0958
Epoch 5/50
13/13 |=================================| — 7 s
     579 ms/step — loss: 1.3341 — accuracy: 0.5610 —
     val_loss: 6.9420 — val_accuracy: 0.1055
Epoch 6/50
13/13 |=================================| — 7 s
     528 ms/step — loss: 1.2630 — accuracy: 0.5884 —
     val_loss: 6.3015 — val_accuracy: 0.1040
Epoch 7/50
13/13 |=================================| — 7 s
     527 ms/step — loss: 1.2040 — accuracy: 0.6097 —
     val_loss: 7.2699 — val_accuracy: 0.0973
Epoch 8/50
13/13 |=================================| — 7 s
     519 ms/step — loss: 1.1299 — accuracy: 0.6349 —
```

```
        val_loss: 7.8449 − val_accuracy: 0.1248
Epoch  9/50
13/13 |================================| − 7s
        530ms/step − loss: 1.0620 − accuracy: 0.6457 −
        val_loss: 6.5887 − val_accuracy: 0.1181
Epoch  10/50
13/13 |================================| − 7s
        578ms/step − loss: 1.0475 − accuracy: 0.6585 −
        val_loss: 6.1091 − val_accuracy: 0.1530
Epoch  11/50
13/13 |================================| − 7s
        548ms/step − loss: 0.9918 − accuracy: 0.6731 −
        val_loss: 6.8350 − val_accuracy: 0.1300
Epoch  12/50
13/13 |================================| − 7s
        554ms/step − loss: 0.9650 − accuracy: 0.6805 −
        val_loss: 8.7384 − val_accuracy: 0.1218
Epoch  13/50
13/13 |================================| − 7s
        530ms/step − loss: 0.9124 − accuracy: 0.7047 −
        val_loss: 6.6468 − val_accuracy: 0.1724
Epoch  14/50
13/13 |================================| − 7s
        526ms/step − loss: 0.9001 − accuracy: 0.6989 −
        val_loss: 4.6609 − val_accuracy: 0.2667
Epoch  15/50
13/13 |================================| − 7s
        552ms/step − loss: 0.8722 − accuracy: 0.7123 −
        val_loss: 4.6417 − val_accuracy: 0.2169
Epoch  16/50
13/13 |================================| − 7s
        552ms/step − loss: 0.8571 − accuracy: 0.7101 −
        val_loss: 5.1253 − val_accuracy: 0.1984
Epoch  17/50
13/13 |================================| − 7s
        548ms/step − loss: 0.8602 − accuracy: 0.7120 −
        val_loss: 4.1271 − val_accuracy: 0.2585
Epoch  18/50
13/13 |================================| − 7s
        522ms/step − loss: 0.8246 − accuracy: 0.7267 −
        val_loss: 3.3107 − val_accuracy: 0.3009
Epoch  19/50
13/13 |================================| − 7s
        554ms/step − loss: 0.8124 − accuracy: 0.7324 −
        val_loss: 3.1957 − val_accuracy: 0.3336
Epoch  20/50
```

13/13 |═══════════════════════════════| — 7s
    524ms/step — loss: 0.7691 — accuracy: 0.7515 —
    val_loss: 2.5840 — val_accuracy: 0.3878
Epoch 21/50
13/13 |═══════════════════════════════| — 7s
    554ms/step — loss: 0.7132 — accuracy: 0.7652 —
    val_loss: 2.7722 — val_accuracy: 0.3633
Epoch 22/50
13/13 |═══════════════════════════════| — 7s
    527ms/step — loss: 0.7131 — accuracy: 0.7576 —
    val_loss: 2.9998 — val_accuracy: 0.3893
Epoch 23/50
13/13 |═══════════════════════════════| — 7s
    551ms/step — loss: 0.6978 — accuracy: 0.7649 —
    val_loss: 2.7941 — val_accuracy: 0.3930
Epoch 24/50
13/13 |═══════════════════════════════| — 7s
    526ms/step — loss: 0.6805 — accuracy: 0.7773 —
    val_loss: 2.7833 — val_accuracy: 0.3863
Epoch 25/50
13/13 |═══════════════════════════════| — 7s
    535ms/step — loss: 0.6599 — accuracy: 0.7735 —
    val_loss: 2.4090 — val_accuracy: 0.4458
Epoch 26/50
13/13 |═══════════════════════════════| — 7s
    527ms/step — loss: 0.6627 — accuracy: 0.7690 —
    val_loss: 2.1606 — val_accuracy: 0.4770
Epoch 27/50
13/13 |═══════════════════════════════| — 7s
    552ms/step — loss: 0.6283 — accuracy: 0.7888 —
    val_loss: 2.1707 — val_accuracy: 0.4799
Epoch 28/50
13/13 |═══════════════════════════════| — 7s
    550ms/step — loss: 0.6529 — accuracy: 0.7799 —
    val_loss: 1.8398 — val_accuracy: 0.5267
Epoch 29/50
13/13 |═══════════════════════════════| — 7s
    516ms/step — loss: 0.6109 — accuracy: 0.7891 —
    val_loss: 2.4791 — val_accuracy: 0.4510
Epoch 30/50
13/13 |═══════════════════════════════| — 7s
    514ms/step — loss: 0.6100 — accuracy: 0.7878 —
    val_loss: 1.7130 — val_accuracy: 0.5602
Epoch 31/50
13/13 |═══════════════════════════════| — 7s
    549ms/step — loss: 0.5976 — accuracy: 0.7939 —

```
    val_loss: 1.6261 − val_accuracy: 0.5461
Epoch 32/50
13/13 |=================================| − 7s
    550ms/step − loss: 0.5836 − accuracy: 0.8073 −
    val_loss: 1.6278 − val_accuracy: 0.5877
Epoch 33/50
13/13 |=================================| − 7s
    524ms/step − loss: 0.5506 − accuracy: 0.8101 −
    val_loss: 1.6033 − val_accuracy: 0.5736
Epoch 34/50
13/13 |=================================| − 7s
    551ms/step − loss: 0.5618 − accuracy: 0.8117 −
    val_loss: 1.6265 − val_accuracy: 0.5416
Epoch 35/50
13/13 |=================================| − 7s
    530ms/step − loss: 0.5345 − accuracy: 0.8226 −
    val_loss: 1.2633 − val_accuracy: 0.6337
Epoch 36/50
13/13 |=================================| − 7s
    553ms/step − loss: 0.5331 − accuracy: 0.8200 −
    val_loss: 1.6336 − val_accuracy: 0.5706
Epoch 37/50
13/13 |=================================| − 7s
    540ms/step − loss: 0.5301 − accuracy: 0.8136 −
    val_loss: 1.4427 − val_accuracy: 0.6092
Epoch 38/50
13/13 |=================================| − 7s
    553ms/step − loss: 0.5106 − accuracy: 0.8318 −
    val_loss: 1.3170 − val_accuracy: 0.6226
Epoch 39/50
13/13 |=================================| − 7s
    550ms/step − loss: 0.4740 − accuracy: 0.8382 −
    val_loss: 1.6223 − val_accuracy: 0.6010
Epoch 40/50
13/13 |=================================| − 7s
    551ms/step − loss: 0.4637 − accuracy: 0.8404 −
    val_loss: 1.1153 − val_accuracy: 0.6776
Epoch 41/50
13/13 |=================================| − 7s
    509ms/step − loss: 0.4513 − accuracy: 0.8487 −
    val_loss: 0.9959 − val_accuracy: 0.7184
Epoch 42/50
13/13 |=================================| − 7s
    550ms/step − loss: 0.4365 − accuracy: 0.8509 −
    val_loss: 0.9558 − val_accuracy: 0.7147
Epoch 43/50
```

```
13/13 [==============================] — 7s
    550ms/step — loss: 0.4258 — accuracy: 0.8614 —
    val_loss: 1.0518 — val_accuracy: 0.6857
Epoch 44/50
13/13 [==============================] — 7s
    523ms/step — loss: 0.4327 — accuracy: 0.8554 —
    val_loss: 1.0526 — val_accuracy: 0.6976
Epoch 45/50
13/13 [==============================] — 7s
    526ms/step — loss: 0.4269 — accuracy: 0.8554 —
    val_loss: 1.1339 — val_accuracy: 0.6857
Epoch 46/50
13/13 [==============================] — 7s
    548ms/step — loss: 0.3857 — accuracy: 0.8758 —
    val_loss: 1.2298 — val_accuracy: 0.6464
Epoch 47/50
13/13 [==============================] — 7s
    523ms/step — loss: 0.4098 — accuracy: 0.8589 —
    val_loss: 0.9001 — val_accuracy: 0.7214
Epoch 48/50
13/13 [==============================] — 7s
    547ms/step — loss: 0.3610 — accuracy: 0.8809 —
    val_loss: 0.8053 — val_accuracy: 0.7533
Epoch 49/50
13/13 [==============================] — 7s
    548ms/step — loss: 0.3879 — accuracy: 0.8691 —
    val_loss: 0.8507 — val_accuracy: 0.7481
Epoch 50/50
13/13 [==============================] — 7s
    579ms/step — loss: 0.3747 — accuracy: 0.8745 —
    val_loss: 0.9204 — val_accuracy: 0.7325
```

- *SGD* with momentum:

```
Epoch 1/50
13/13 [==============================] — 7s
    555ms/step — loss: 2.9502 — accuracy: 0.1778 —
    val_loss: 9.1294 — val_accuracy: 0.0654
Epoch 2/50
13/13 [==============================] — 7s
    550ms/step — loss: 2.1657 — accuracy: 0.3291 —
    val_loss: 5.3749 — val_accuracy: 0.1137
Epoch 3/50
13/13 [==============================] — 7s
    527ms/step — loss: 1.8060 — accuracy: 0.3979 —
    val_loss: 3.2172 — val_accuracy: 0.2734
```

```
Epoch 4/50
13/13 |=================================| — 7s
    555ms/step — loss: 1.5775 — accuracy: 0.4693 —
    val_loss: 2.6253 — val_accuracy: 0.2801
Epoch 5/50
13/13 |=================================| — 7s
    522ms/step — loss: 1.4310 — accuracy: 0.5256 —
    val_loss: 3.1207 — val_accuracy: 0.3150
Epoch 6/50
13/13 |=================================| — 7s
    576ms/step — loss: 1.3381 — accuracy: 0.5623 —
    val_loss: 4.6070 — val_accuracy: 0.2073
Epoch 7/50
13/13 |=================================| — 7s
    516ms/step — loss: 1.2582 — accuracy: 0.5846 —
    val_loss: 4.6418 — val_accuracy: 0.2147
Epoch 8/50
13/13 |=================================| — 7s
    551ms/step — loss: 1.2478 — accuracy: 0.5887 —
    val_loss: 5.7992 — val_accuracy: 0.2281
Epoch 9/50
13/13 |=================================| — 7s
    549ms/step — loss: 1.2192 — accuracy: 0.5945 —
    val_loss: 3.0156 — val_accuracy: 0.3581
Epoch 10/50
13/13 |=================================| — 7s
    547ms/step — loss: 1.1139 — accuracy: 0.6384 —
    val_loss: 4.3278 — val_accuracy: 0.2949
Epoch 11/50
13/13 |=================================| — 7s
    523ms/step — loss: 1.1068 — accuracy: 0.6384 —
    val_loss: 4.7447 — val_accuracy: 0.3098
Epoch 12/50
13/13 |=================================| — 7s
    549ms/step — loss: 1.0648 — accuracy: 0.6349 —
    val_loss: 4.2324 — val_accuracy: 0.3210
Epoch 13/50
13/13 |=================================| — 7s
    524ms/step — loss: 1.0441 — accuracy: 0.6489 —
    val_loss: 5.2549 — val_accuracy: 0.2504
Epoch 14/50
13/13 |=================================| — 7s
    551ms/step — loss: 0.9998 — accuracy: 0.6645 —
    val_loss: 4.0356 — val_accuracy: 0.3366
Epoch 15/50
13/13 |=================================| — 7s
```

```
547ms/step — loss: 0.9966 — accuracy: 0.6690 —
   val_loss: 4.3529 — val_accuracy: 0.3024
Epoch 16/50
13/13 |==============================| — 7s
   523ms/step — loss: 0.9633 — accuracy: 0.6802 —
   val_loss: 3.7847 — val_accuracy: 0.3380
Epoch 17/50
13/13 |==============================| — 7s
   531ms/step — loss: 0.9270 — accuracy: 0.6888 —
   val_loss: 4.0426 — val_accuracy: 0.3559
Epoch 18/50
13/13 |==============================| — 7s
   525ms/step — loss: 0.9252 — accuracy: 0.6849 —
   val_loss: 3.9179 — val_accuracy: 0.3425
Epoch 19/50
13/13 |==============================| — 7s
   524ms/step — loss: 0.9167 — accuracy: 0.6881 —
   val_loss: 3.9122 — val_accuracy: 0.3410
Epoch 20/50
13/13 |==============================| — 7s
   524ms/step — loss: 0.8917 — accuracy: 0.7050 —
   val_loss: 3.7557 — val_accuracy: 0.3648
Epoch 21/50
13/13 |==============================| — 7s
   523ms/step — loss: 0.8786 — accuracy: 0.6980 —
   val_loss: 3.0951 — val_accuracy: 0.3782
Epoch 22/50
13/13 |==============================| — 7s
   524ms/step — loss: 0.8609 — accuracy: 0.7053 —
   val_loss: 3.1217 — val_accuracy: 0.4101
Epoch 23/50
13/13 |==============================| — 7s
   556ms/step — loss: 0.8570 — accuracy: 0.7114 —
   val_loss: 3.3554 — val_accuracy: 0.3484
Epoch 24/50
13/13 |==============================| — 7s
   550ms/step — loss: 0.8681 — accuracy: 0.7012 —
   val_loss: 2.6661 — val_accuracy: 0.4108
Epoch 25/50
13/13 |==============================| — 7s
   550ms/step — loss: 0.8293 — accuracy: 0.7216 —
   val_loss: 3.0418 — val_accuracy: 0.3997
Epoch 26/50
13/13 |==============================| — 7s
   529ms/step — loss: 0.8022 — accuracy: 0.7197 —
   val_loss: 2.4638 — val_accuracy: 0.4138
```

Epoch 27/50
13/13 [==============================] — 7s
    554ms/step — loss: 0.7951 — accuracy: 0.7289 —
    val_loss: 2.5504 — val_accuracy: 0.4510
Epoch 28/50
13/13 [==============================] — 7s
    528ms/step — loss: 0.8309 — accuracy: 0.7111 —
    val_loss: 3.4046 — val_accuracy: 0.3685
Epoch 29/50
13/13 [==============================] — 7s
    554ms/step — loss: 0.7761 — accuracy: 0.7397 —
    val_loss: 2.9765 — val_accuracy: 0.3789
Epoch 30/50
13/13 [==============================] — 7s
    524ms/step — loss: 0.7841 — accuracy: 0.7337 —
    val_loss: 2.2967 — val_accuracy: 0.4577
Epoch 31/50
13/13 [==============================] — 7s
    552ms/step — loss: 0.7868 — accuracy: 0.7372 —
    val_loss: 2.1040 — val_accuracy: 0.4740
Epoch 32/50
13/13 [==============================] — 7s
    550ms/step — loss: 0.7381 — accuracy: 0.7461 —
    val_loss: 2.2414 — val_accuracy: 0.4473
Epoch 33/50
13/13 [==============================] — 7s
    551ms/step — loss: 0.7421 — accuracy: 0.7381 —
    val_loss: 1.6369 — val_accuracy: 0.5371
Epoch 34/50
13/13 [==============================] — 7s
    547ms/step — loss: 0.7403 — accuracy: 0.7455 —
    val_loss: 1.8278 — val_accuracy: 0.5126
Epoch 35/50
13/13 [==============================] — 7s
    550ms/step — loss: 0.6998 — accuracy: 0.7611 —
    val_loss: 1.9048 — val_accuracy: 0.5037
Epoch 36/50
13/13 [==============================] — 7s
    549ms/step — loss: 0.7302 — accuracy: 0.7439 —
    val_loss: 2.3190 — val_accuracy: 0.4614
Epoch 37/50
13/13 [==============================] — 7s
    524ms/step — loss: 0.7240 — accuracy: 0.7572 —
    val_loss: 2.5156 — val_accuracy: 0.4250
Epoch 38/50
13/13 [==============================] — 7s

```
    522ms/step − loss: 0.6823 − accuracy: 0.7665 −
    val_loss: 1.7946 − val_accuracy: 0.5357
Epoch 39/50
13/13 |========================================| − 7s
    525ms/step − loss: 0.6778 − accuracy: 0.7665 −
    val_loss: 1.9893 − val_accuracy: 0.4777
Epoch 40/50
13/13 |========================================| − 7s
    549ms/step − loss: 0.6694 − accuracy: 0.7639 −
    val_loss: 1.8171 − val_accuracy: 0.5119
Epoch 41/50
13/13 |========================================| − 7s
    511ms/step − loss: 0.6569 − accuracy: 0.7725 −
    val_loss: 1.8628 − val_accuracy: 0.5059
Epoch 42/50
13/13 |========================================| − 7s
    518ms/step − loss: 0.6794 − accuracy: 0.7630 −
    val_loss: 1.6079 − val_accuracy: 0.5453
Epoch 43/50
13/13 |========================================| − 7s
    528ms/step − loss: 0.6548 − accuracy: 0.7780 −
    val_loss: 1.4777 − val_accuracy: 0.5743
Epoch 44/50
13/13 |========================================| − 7s
    552ms/step − loss: 0.6571 − accuracy: 0.7706 −
    val_loss: 1.2754 − val_accuracy: 0.6152
Epoch 45/50
13/13 |========================================| − 7s
    553ms/step − loss: 0.6565 − accuracy: 0.7646 −
    val_loss: 1.5146 − val_accuracy: 0.5788
Epoch 46/50
13/13 |========================================| − 7s
    529ms/step − loss: 0.6114 − accuracy: 0.7888 −
    val_loss: 1.3068 − val_accuracy: 0.6114
Epoch 47/50
13/13 |========================================| − 7s
    550ms/step − loss: 0.6261 − accuracy: 0.7840 −
    val_loss: 1.3092 − val_accuracy: 0.6211
Epoch 48/50
13/13 |========================================| − 7s
    528ms/step − loss: 0.6012 − accuracy: 0.7948 −
    val_loss: 1.8828 − val_accuracy: 0.5082
Epoch 49/50
13/13 |========================================| − 7s
    527ms/step − loss: 0.6151 − accuracy: 0.7780 −
    val_loss: 1.3657 − val_accuracy: 0.5906
```

Epoch 50/50

13/13 |==============================| — 7 s

531ms/step — loss: 0.6014 — accuracy: 0.7901 —
val_loss: 1.6430 — val_accuracy: 0.5483

- *RMSProp*:

Epoch 1/100

13/13 |==============================| — 8 s

597ms/step — loss: 1.3720 — accuracy: 0.5887 —
val_loss: 2.4956 — val_accuracy: 0.5208

Epoch 2/100

13/13 |==============================| — 7 s

565ms/step — loss: 0.9159 — accuracy: 0.6865 —
val_loss: 1.7508 — val_accuracy: 0.6330

Epoch 3/100

13/13 |==============================| — 7 s

540ms/step — loss: 0.8487 — accuracy: 0.7053 —
val_loss: 1.7289 — val_accuracy: 0.6315

Epoch 4/100

13/13 |==============================| — 7 s

543ms/step — loss: 0.7594 — accuracy: 0.7407 —
val_loss: 1.4134 — val_accuracy: 0.6404

Epoch 5/100

13/13 |==============================| — 7 s

559ms/step — loss: 0.7878 — accuracy: 0.7305 —
val_loss: 1.6247 — val_accuracy: 0.6360

Epoch 6/100

13/13 |==============================| — 7 s

565ms/step — loss: 0.7488 — accuracy: 0.7391 —
val_loss: 1.7420 — val_accuracy: 0.5973

Epoch 7/100

13/13 |==============================| — 7 s

541ms/step — loss: 0.7076 — accuracy: 0.7531 —
val_loss: 1.7218 — val_accuracy: 0.6159

Epoch 8/100

13/13 |==============================| — 7 s

540ms/step — loss: 0.6954 — accuracy: 0.7509 —
val_loss: 1.7233 — val_accuracy: 0.5936

Epoch 9/100

13/13 |==============================| — 7 s

566ms/step — loss: 0.6783 — accuracy: 0.7633 —
val_loss: 1.6141 — val_accuracy: 0.6256

Epoch 10/100

13/13 |==============================| — 7 s

527ms/step — loss: 0.6470 — accuracy: 0.7802 —

```
      val_loss:  1.8207  −  val_accuracy:  0.5973
Epoch  11/100
13/13 |                                        | − 7 s
      539ms/step  −  loss:  0.6232  −  accuracy:  0.7792  −
      val_loss:  1.1202  −  val_accuracy:  0.7088
Epoch  12/100
13/13 |                                        | − 7 s
      544ms/step  −  loss:  0.5668  −  accuracy:  0.8104  −
      val_loss:  1.7623  −  val_accuracy:  0.5892
Epoch  13/100
13/13 |                                        | − 7 s
      566ms/step  −  loss:  0.5933  −  accuracy:  0.7936  −
      val_loss:  0.9784  −  val_accuracy:  0.7370
Epoch  14/100
13/13 |                                        | − 7 s
      540ms/step  −  loss:  0.5348  −  accuracy:  0.8133  −
      val_loss:  0.9780  −  val_accuracy:  0.7088
Epoch  15/100
13/13 |                                        | − 7 s
      569ms/step  −  loss:  0.5608  −  accuracy:  0.8063  −
      val_loss:  1.2959  −  val_accuracy:  0.6746
Epoch  16/100
13/13 |                                        | − 7 s
      542ms/step  −  loss:  0.5454  −  accuracy:  0.8136  −
      val_loss:  1.0952  −  val_accuracy:  0.7132
Epoch  17/100
13/13 |                                        | − 7 s
      539ms/step  −  loss:  0.4993  −  accuracy:  0.8312  −
      val_loss:  1.8109  −  val_accuracy:  0.5966
Epoch  18/100
13/13 |                                        | − 7 s
      564ms/step  −  loss:  0.5040  −  accuracy:  0.8257  −
      val_loss:  1.2496  −  val_accuracy:  0.6664
Epoch  19/100
13/13 |                                        | − 7 s
      541ms/step  −  loss:  0.4630  −  accuracy:  0.8484  −
      val_loss:  1.0953  −  val_accuracy:  0.6961
Epoch  20/100
13/13 |                                        | − 7 s
      548ms/step  −  loss:  0.4641  −  accuracy:  0.8375  −
      val_loss:  1.5131  −  val_accuracy:  0.6285
Epoch  21/100
13/13 |                                        | − 7 s
      540ms/step  −  loss:  0.4606  −  accuracy:  0.8423  −
      val_loss:  1.2650  −  val_accuracy:  0.6412
Epoch  22/100
```

```
13/13 [==============================] — 7s
    562ms/step — loss: 0.4611 — accuracy: 0.8442 —
    val_loss: 1.0623 — val_accuracy: 0.7006
Epoch 23/100
13/13 [==============================] — 7s
    562ms/step — loss: 0.4121 — accuracy: 0.8646 —
    val_loss: 1.1792 — val_accuracy: 0.6568
Epoch 24/100
13/13 [==============================] — 7s
    566ms/step — loss: 0.4215 — accuracy: 0.8570 —
    val_loss: 1.0076 — val_accuracy: 0.7147
Epoch 25/100
13/13 [==============================] — 7s
    546ms/step — loss: 0.4291 — accuracy: 0.8525 —
    val_loss: 0.9208 — val_accuracy: 0.7162
Epoch 26/100
13/13 [==============================] — 7s
    542ms/step — loss: 0.3916 — accuracy: 0.8665 —
    val_loss: 1.0808 — val_accuracy: 0.6954
Epoch 27/100
13/13 [==============================] — 7s
    564ms/step — loss: 0.3824 — accuracy: 0.8735 —
    val_loss: 1.0921 — val_accuracy: 0.6947
Epoch 28/100
13/13 [==============================] — 8s
    573ms/step — loss: 0.3613 — accuracy: 0.8735 —
    val_loss: 0.8696 — val_accuracy: 0.7311
Epoch 29/100
13/13 [==============================] — 7s
    565ms/step — loss: 0.3592 — accuracy: 0.8793 —
    val_loss: 0.8901 — val_accuracy: 0.7058
Epoch 30/100
13/13 [==============================] — 7s
    539ms/step — loss: 0.3330 — accuracy: 0.8856 —
    val_loss: 1.3934 — val_accuracy: 0.6330
Epoch 31/100
13/13 [==============================] — 7s
    543ms/step — loss: 0.3367 — accuracy: 0.8907 —
    val_loss: 1.2554 — val_accuracy: 0.6716
Epoch 32/100
13/13 [==============================] — 7s
    553ms/step — loss: 0.3169 — accuracy: 0.8939 —
    val_loss: 1.1773 — val_accuracy: 0.7058
Epoch 33/100
13/13 [==============================] — 7s
    539ms/step — loss: 0.3388 — accuracy: 0.8869 —
```

```
val_loss: 1.0605 − val_accuracy: 0.7080
Epoch 34/100
13/13 [==============================] − 7s
    567ms/step − loss: 0.2997 − accuracy: 0.8993 −
    val_loss: 1.0617 − val_accuracy: 0.7058
Epoch 35/100
13/13 [==============================] − 7s
    555ms/step − loss: 0.2933 − accuracy: 0.8971 −
    val_loss: 1.0686 − val_accuracy: 0.7132
Epoch 36/100
13/13 [==============================] − 7s
    539ms/step − loss: 0.2886 − accuracy: 0.9022 −
    val_loss: 0.9728 − val_accuracy: 0.7214
Epoch 37/100
13/13 [==============================] − 7s
    571ms/step − loss: 0.2666 − accuracy: 0.9086 −
    val_loss: 0.7623 − val_accuracy: 0.7719
Epoch 38/100
13/13 [==============================] − 7s
    567ms/step − loss: 0.2664 − accuracy: 0.9143 −
    val_loss: 0.9762 − val_accuracy: 0.7088
Epoch 39/100
13/13 [==============================] − 7s
    542ms/step − loss: 0.2797 − accuracy: 0.9105 −
    val_loss: 1.2288 − val_accuracy: 0.6828
Epoch 40/100
13/13 [==============================] − 7s
    564ms/step − loss: 0.2695 − accuracy: 0.9076 −
    val_loss: 0.9058 − val_accuracy: 0.7511
Epoch 41/100
13/13 [==============================] − 7s
    566ms/step − loss: 0.2482 − accuracy: 0.9207 −
    val_loss: 1.1604 − val_accuracy: 0.6954
Epoch 42/100
13/13 [==============================] − 7s
    561ms/step − loss: 0.2699 − accuracy: 0.9092 −
    val_loss: 0.7789 − val_accuracy: 0.7704
Epoch 43/100
13/13 [==============================] − 7s
    567ms/step − loss: 0.2350 − accuracy: 0.9261 −
    val_loss: 0.6864 − val_accuracy: 0.7972
Epoch 44/100
13/13 [==============================] − 7s
    542ms/step − loss: 0.2497 − accuracy: 0.9146 −
    val_loss: 0.8458 − val_accuracy: 0.7541
Epoch 45/100
```

13/13 [==============================] — 7s
564ms/step — loss: 0.2547 — accuracy: 0.9133 —
val_loss: 0.6558 — val_accuracy: 0.8016
Epoch 46/100
13/13 [==============================] — 7s
566ms/step — loss: 0.2131 — accuracy: 0.9248 —
val_loss: 0.7017 — val_accuracy: 0.7883
Epoch 47/100
13/13 [==============================] — 7s
541ms/step — loss: 0.2155 — accuracy: 0.9267 —
val_loss: 0.9419 — val_accuracy: 0.7355
Epoch 48/100
13/13 [==============================] — 7s
566ms/step — loss: 0.1988 — accuracy: 0.9369 —
val_loss: 0.6787 — val_accuracy: 0.7949
Epoch 49/100
13/13 [==============================] — 7s
569ms/step — loss: 0.2117 — accuracy: 0.9302 —
val_loss: 0.8246 — val_accuracy: 0.7675
Epoch 50/100
13/13 [==============================] — 8s
604ms/step — loss: 0.1911 — accuracy: 0.9395 —
val_loss: 0.7649 — val_accuracy: 0.7786
Epoch 51/100
13/13 [==============================] — 7s
547ms/step — loss: 0.1970 — accuracy: 0.9353 —
val_loss: 0.9084 — val_accuracy: 0.7474
Epoch 52/100
13/13 [==============================] — 7s
567ms/step — loss: 0.1863 — accuracy: 0.9356 —
val_loss: 0.6976 — val_accuracy: 0.7987
Epoch 53/100
13/13 [==============================] — 7s
543ms/step — loss: 0.1959 — accuracy: 0.9337 —
val_loss: 0.7490 — val_accuracy: 0.8024
Epoch 54/100
13/13 [==============================] — 8s
572ms/step — loss: 0.1882 — accuracy: 0.9388 —
val_loss: 0.9558 — val_accuracy: 0.7422
Epoch 55/100
13/13 [==============================] — 7s
542ms/step — loss: 0.1698 — accuracy: 0.9449 —
val_loss: 0.7288 — val_accuracy: 0.7831
Epoch 56/100
13/13 [==============================] — 7s
544ms/step — loss: 0.1957 — accuracy: 0.9350 —

```
    val_loss: 1.2521 − val_accuracy: 0.6991
Epoch 57/100
13/13 |=============================| − 7s
    545ms/step − loss: 0.1876 − accuracy: 0.9360 −
    val_loss: 0.8010 − val_accuracy: 0.7779
Epoch 58/100
13/13 |=============================| − 7s
    545ms/step − loss: 0.1657 − accuracy: 0.9414 −
    val_loss: 0.7565 − val_accuracy: 0.7682
Epoch 59/100
13/13 |=============================| − 7s
    566ms/step − loss: 0.1467 − accuracy: 0.9503 −
    val_loss: 0.9033 − val_accuracy: 0.7556
Epoch 60/100
13/13 |=============================| − 7s
    538ms/step − loss: 0.1495 − accuracy: 0.9529 −
    val_loss: 0.7663 − val_accuracy: 0.7897
Epoch 61/100
13/13 |=============================| − 7s
    569ms/step − loss: 0.1607 − accuracy: 0.9535 −
    val_loss: 0.6943 − val_accuracy: 0.7987
Epoch 62/100
13/13 |=============================| − 7s
    567ms/step − loss: 0.1394 − accuracy: 0.9535 −
    val_loss: 0.7970 − val_accuracy: 0.7935
Epoch 63/100
13/13 |=============================| − 7s
    569ms/step − loss: 0.1589 − accuracy: 0.9478 −
    val_loss: 0.7388 − val_accuracy: 0.8016
Epoch 64/100
13/13 |=============================| − 7s
    542ms/step − loss: 0.1553 − accuracy: 0.9455 −
    val_loss: 0.7506 − val_accuracy: 0.7964
Epoch 65/100
13/13 |=============================| − 7s
    565ms/step − loss: 0.1268 − accuracy: 0.9589 −
    val_loss: 0.8695 − val_accuracy: 0.7816
Epoch 66/100
13/13 |=============================| − 7s
    540ms/step − loss: 0.1446 − accuracy: 0.9557 −
    val_loss: 0.8283 − val_accuracy: 0.7727
Epoch 67/100
13/13 |=============================| − 7s
    567ms/step − loss: 0.1459 − accuracy: 0.9513 −
    val_loss: 0.9289 − val_accuracy: 0.7385
Epoch 68/100
```

```
13/13 [==============================] — 7s
     542ms/step — loss: 0.1408 — accuracy: 0.9570 —
     val_loss: 0.8139 — val_accuracy: 0.7860
Epoch 69/100
13/13 [==============================] — 7s
     542ms/step — loss: 0.1354 — accuracy: 0.9592 —
     val_loss: 0.7703 — val_accuracy: 0.7920
Epoch 70/100
13/13 [==============================] — 7s
     537ms/step — loss: 0.1375 — accuracy: 0.9554 —
     val_loss: 0.7768 — val_accuracy: 0.7964
Epoch 71/100
13/13 [==============================] — 7s
     553ms/step — loss: 0.1161 — accuracy: 0.9624 —
     val_loss: 1.0211 — val_accuracy: 0.7467
Epoch 72/100
13/13 [==============================] — 7s
     541ms/step — loss: 0.1390 — accuracy: 0.9554 —
     val_loss: 0.8718 — val_accuracy: 0.7727
Epoch 73/100
13/13 [==============================] — 7s
     544ms/step — loss: 0.1163 — accuracy: 0.9637 —
     val_loss: 0.8275 — val_accuracy: 0.7823
Epoch 74/100
13/13 [==============================] — 7s
     543ms/step — loss: 0.1143 — accuracy: 0.9627 —
     val_loss: 0.7667 — val_accuracy: 0.8039
Epoch 75/100
13/13 [==============================] — 7s
     563ms/step — loss: 0.1125 — accuracy: 0.9624 —
     val_loss: 0.7084 — val_accuracy: 0.8001
Epoch 76/100
13/13 [==============================] — 7s
     567ms/step — loss: 0.1093 — accuracy: 0.9653 —
     val_loss: 0.6691 — val_accuracy: 0.8113
Epoch 77/100
13/13 [==============================] — 7s
     558ms/step — loss: 0.1100 — accuracy: 0.9627 —
     val_loss: 0.7732 — val_accuracy: 0.7845
Epoch 78/100
13/13 [==============================] — 7s
     544ms/step — loss: 0.1206 — accuracy: 0.9576 —
     val_loss: 0.7527 — val_accuracy: 0.7987
Epoch 79/100
13/13 [==============================] — 7s
     563ms/step — loss: 0.1109 — accuracy: 0.9627 —
```

```
val_loss: 0.7223 − val_accuracy: 0.7994
Epoch 80/100
13/13 [==============================] − 7s
    571ms/step − loss: 0.1124 − accuracy: 0.9669 −
    val_loss: 0.7425 − val_accuracy: 0.7979
Epoch 81/100
13/13 [==============================] − 7s
    547ms/step − loss: 0.1112 − accuracy: 0.9611 −
    val_loss: 0.7055 − val_accuracy: 0.7964
Epoch 82/100
13/13 [==============================] − 7s
    566ms/step − loss: 0.1038 − accuracy: 0.9656 −
    val_loss: 0.8155 − val_accuracy: 0.7816
Epoch 83/100
13/13 [==============================] − 7s
    546ms/step − loss: 0.1041 − accuracy: 0.9681 −
    val_loss: 0.7890 − val_accuracy: 0.7927
Epoch 84/100
13/13 [==============================] − 7s
    545ms/step − loss: 0.0984 − accuracy: 0.9707 −
    val_loss: 0.7037 − val_accuracy: 0.8053
Epoch 85/100
13/13 [==============================] − 7s
    568ms/step − loss: 0.1180 − accuracy: 0.9630 −
    val_loss: 0.8296 − val_accuracy: 0.7734
Epoch 86/100
13/13 [==============================] − 7s
    547ms/step − loss: 0.1076 − accuracy: 0.9653 −
    val_loss: 0.7393 − val_accuracy: 0.8068
Epoch 87/100
13/13 [==============================] − 7s
    585ms/step − loss: 0.0802 − accuracy: 0.9761 −
    val_loss: 0.7854 − val_accuracy: 0.8039
Epoch 88/100
13/13 [==============================] − 7s
    566ms/step − loss: 0.0838 − accuracy: 0.9761 −
    val_loss: 0.8651 − val_accuracy: 0.7868
Epoch 89/100
13/13 [==============================] − 7s
    564ms/step − loss: 0.1050 − accuracy: 0.9665 −
    val_loss: 0.8340 − val_accuracy: 0.7860
Epoch 90/100
13/13 [==============================] − 7s
    546ms/step − loss: 0.1025 − accuracy: 0.9634 −
    val_loss: 0.8373 − val_accuracy: 0.7972
Epoch 91/100
```

13/13 [==============================] – 7s
564ms/step – loss: 0.0855 – accuracy: 0.9716 –
val_loss: 0.8590 – val_accuracy: 0.7927
Epoch 92/100
13/13 [==============================] – 7s
542ms/step – loss: 0.1038 – accuracy: 0.9653 –
val_loss: 0.9127 – val_accuracy: 0.7816
Epoch 93/100
13/13 [==============================] – 7s
541ms/step – loss: 0.0871 – accuracy: 0.9723 –
val_loss: 0.8365 – val_accuracy: 0.7897
Epoch 94/100
13/13 [==============================] – 7s
567ms/step – loss: 0.0910 – accuracy: 0.9748 –
val_loss: 0.8536 – val_accuracy: 0.7912
Epoch 95/100
13/13 [==============================] – 7s
563ms/step – loss: 0.0935 – accuracy: 0.9713 –
val_loss: 0.7639 – val_accuracy: 0.8083
Epoch 96/100
13/13 [==============================] – 7s
564ms/step – loss: 0.0716 – accuracy: 0.9764 –
val_loss: 0.7929 – val_accuracy: 0.8068
Epoch 97/100
13/13 [==============================] – 7s
545ms/step – loss: 0.0815 – accuracy: 0.9736 –
val_loss: 0.8815 – val_accuracy: 0.7868
Epoch 98/100
13/13 [==============================] – 7s
564ms/step – loss: 0.0729 – accuracy: 0.9761 –
val_loss: 0.7437 – val_accuracy: 0.8091
Epoch 99/100
13/13 [==============================] – 7s
534ms/step – loss: 0.0890 – accuracy: 0.9701 –
val_loss: 0.8621 – val_accuracy: 0.7897
Epoch 100/100
13/13 [==============================] – 7s
537ms/step – loss: 0.0938 – accuracy: 0.9707 –
val_loss: 0.7245 – val_accuracy: 0.8061