ResNet（一个只有 10 层的网络，每个残差块只有 1 个）

Epoch 1/100
97/97 [==============================] - 14s 59ms/step - loss: 1.5263 - sparse_categorical_accuracy: 0.4869 - val_loss: 2.7756 - val_sparse_categorical_accuracy: 0.1773
Epoch 2/100
97/97 [==============================] - 5s 50ms/step - loss: 1.2064 - sparse_categorical_accuracy: 0.5918 - val_loss: 3.2594 - val_sparse_categorical_accuracy: 0.1805
Epoch 3/100
97/97 [==============================] - 5s 48ms/step - loss: 1.0184 - sparse_categorical_accuracy: 0.6574 - val_loss: 3.0943 - val_sparse_categorical_accuracy: 0.2203
Epoch 4/100
97/97 [==============================] - 5s 49ms/step - loss: 0.9138 - sparse_categorical_accuracy: 0.6925 - val_loss: 2.3398 - val_sparse_categorical_accuracy: 0.3375
Epoch 5/100
97/97 [==============================] - 5s 49ms/step - loss: 0.7423 - sparse_categorical_accuracy: 0.7519 - val_loss: 1.7288 - val_sparse_categorical_accuracy: 0.4977
Epoch 6/100
97/97 [==============================] - 5s 49ms/step - loss: 0.5983 - sparse_categorical_accuracy: 0.8010 - val_loss: 3.7341 - val_sparse_categorical_accuracy: 0.2016
Epoch 7/100
97/97 [==============================] - 5s 48ms/step - loss: 0.4384 - sparse_categorical_accuracy: 0.8541 - val_loss: 2.8779 - val_sparse_categorical_accuracy: 0.3898
Epoch 8/100
97/97 [==============================] - 5s 48ms/step - loss: 0.2856 - sparse_categorical_accuracy: 0.9074 - val_loss: 4.8942 - val_sparse_categorical_accuracy: 0.2328
Epoch 9/100
97/97 [==============================] - 5s 51ms/step - loss: 0.2147 - sparse_categorical_accuracy: 0.9293 - val_loss: 2.6714 - val_sparse_categorical_accuracy: 0.4305
Epoch 10/100
97/97 [==============================] - 5s 49ms/step - loss: 0.1511 - sparse_categorical_accuracy: 0.9524 - val_loss: 2.1083 - val_sparse_categorical_accuracy: 0.5539
Epoch 11/100
97/97 [==============================] - 5s 48ms/step - loss: 0.0970 - sparse_categorical_accuracy: 0.9709 - val_loss: 2.1177 - val_sparse_categorical_accuracy: 0.5703
Epoch 12/100
97/97 [==============================] - 5s 48ms/step - loss: 0.0547 - sparse_categorical_accuracy: 0.9869 - val_loss: 1.8505 - val_sparse_categorical_accuracy: 0.6008
Epoch 13/100
97/97 [==============================] - 5s 49ms/step - loss: 0.0372 - sparse_categorical_accuracy: 0.9918 - val_loss: 2.2173 - val_sparse_categorical_accuracy: 0.5820
Epoch 14/100
97/97 [==============================] - 5s 49ms/step - loss: 0.0281 - sparse_categorical_accuracy: 0.9948 - val_loss: 1.8926 - val_sparse_categorical_accuracy: 0.6187

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Epoch 15/100
97/97 [==============================] - 5s 47ms/step - loss: 0.0270 - sparse_categorical_acc
uracy: 0.9941 - val_loss: 2.1141 - val_sparse_categorical_accuracy: 0.5977
Epoch 16/100
97/97 [==============================] - 5s 51ms/step - loss: 0.0302 - sparse_categorical_acc
uracy: 0.9927 - val_loss: 2.1938 - val_sparse_categorical_accuracy: 0.5789
Epoch 17/100
97/97 [==============================] - 5s 49ms/step - loss: 0.0865 - sparse_categorical_acc
uracy: 0.9705 - val_loss: 9.7043 - val_sparse_categorical_accuracy: 0.2930
Epoch 18/100
97/97 [==============================] - 5s 49ms/step - loss: 0.1120 - sparse_categorical_acc
uracy: 0.9621 - val_loss: 3.6609 - val_sparse_categorical_accuracy: 0.4328
Epoch 19/100
97/97 [==============================] - 5s 49ms/step - loss: 0.1387 - sparse_categorical_acc
uracy: 0.9538 - val_loss: 2.5565 - val_sparse_categorical_accuracy: 0.5562
Epoch 20/100
97/97 [==============================] - 5s 49ms/step - loss: 0.0602 - sparse_categorical_acc
uracy: 0.9812 - val_loss: 1.7691 - val_sparse_categorical_accuracy: 0.6344
Epoch 21/100
97/97 [==============================] - 5s 49ms/step - loss: 0.0203 - sparse_categorical_acc
uracy: 0.9959 - val_loss: 1.6835 - val_sparse_categorical_accuracy: 0.6500
Epoch 22/100
97/97 [==============================] - 5s 49ms/step - loss: 0.0076 - sparse_categorical_acc
uracy: 0.9987 - val_loss: 1.5633 - val_sparse_categorical_accuracy: 0.6758
Epoch 23/100
97/97 [==============================] - 5s 50ms/step - loss: 0.0065 - sparse_categorical_acc
uracy: 0.9985 - val_loss: 1.5065 - val_sparse_categorical_accuracy: 0.6953
Epoch 24/100
97/97 [==============================] - 5s 49ms/step - loss: 0.0052 - sparse_categorical_acc
uracy: 0.9985 - val_loss: 1.5302 - val_sparse_categorical_accuracy: 0.6992
Epoch 25/100
97/97 [==============================] - 5s 49ms/step - loss: 0.0053 - sparse_categorical_acc
uracy: 0.9985 - val_loss: 1.4685 - val_sparse_categorical_accuracy: 0.6969
Epoch 26/100
97/97 [==============================] - 5s 48ms/step - loss: 0.0040 - sparse_categorical_acc
uracy: 0.9985 - val_loss: 1.5238 - val_sparse_categorical_accuracy: 0.6953
Epoch 27/100
97/97 [==============================] - 5s 48ms/step - loss: 0.0034 - sparse_categorical_acc
uracy: 0.9987 - val_loss: 1.5190 - val_sparse_categorical_accuracy: 0.6953
Epoch 28/100
97/97 [==============================] - 5s 50ms/step - loss: 0.0031 - sparse_categorical_acc
uracy: 0.9985 - val_loss: 1.5075 - val_sparse_categorical_accuracy: 0.6961
Epoch 29/100
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97/97 [==============================] - 5s 49ms/step - loss: 0.0027 - sparse_categorical_acc
uracy: 0.9987 - val_loss: 1.5499 - val_sparse_categorical_accuracy: 0.6961
Epoch 30/100
97/97 [==============================] - 5s 50ms/step - loss: 0.0028 - sparse_categorical_acc
uracy: 0.9985 - val_loss: 1.5272 - val_sparse_categorical_accuracy: 0.7000
Epoch 31/100
97/97 [==============================] - 5s 47ms/step - loss: 0.0028 - sparse_categorical_acc
uracy: 0.9986 - val_loss: 1.6137 - val_sparse_categorical_accuracy: 0.6930
Epoch 32/100
97/97 [==============================] - 5s 49ms/step - loss: 0.0025 - sparse_categorical_acc
uracy: 0.9988 - val_loss: 1.5402 - val_sparse_categorical_accuracy: 0.7016
Epoch 33/100
97/97 [==============================] - 5s 49ms/step - loss: 0.0024 - sparse_categorical_acc
uracy: 0.9987 - val_loss: 1.5400 - val_sparse_categorical_accuracy: 0.7039
Epoch 34/100
97/97 [==============================] - 5s 49ms/step - loss: 0.0025 - sparse_categorical_acc
uracy: 0.9985 - val_loss: 1.5840 - val_sparse_categorical_accuracy: 0.6961
Epoch 35/100
97/97 [==============================] - 5s 48ms/step - loss: 0.0028 - sparse_categorical_acc
uracy: 0.9986 - val_loss: 1.6587 - val_sparse_categorical_accuracy: 0.6938
Epoch 36/100
97/97 [==============================] - 5s 49ms/step - loss: 0.0025 - sparse_categorical_acc
uracy: 0.9990 - val_loss: 1.6435 - val_sparse_categorical_accuracy: 0.6992
Epoch 37/100
97/97 [==============================] - 5s 52ms/step - loss: 0.0641 - sparse_categorical_acc
uracy: 0.9787 - val_loss: 7.0783 - val_sparse_categorical_accuracy: 0.3266
Epoch 38/100
97/97 [==============================] - 5s 48ms/step - loss: 0.4573 - sparse_categorical_acc
uracy: 0.8520 - val_loss: 2.1793 - val_sparse_categorical_accuracy: 0.5039
Epoch 39/100
97/97 [==============================] - 5s 49ms/step - loss: 0.1154 - sparse_categorical_acc
uracy: 0.9620 - val_loss: 2.6344 - val_sparse_categorical_accuracy: 0.4977
Epoch 40/100
97/97 [==============================] - 5s 48ms/step - loss: 0.0228 - sparse_categorical_acc
uracy: 0.9946 - val_loss: 1.8134 - val_sparse_categorical_accuracy: 0.6070
Epoch 41/100
97/97 [==============================] - 5s 49ms/step - loss: 0.0080 - sparse_categorical_acc
uracy: 0.9983 - val_loss: 1.4658 - val_sparse_categorical_accuracy: 0.6773
Epoch 42/100
97/97 [==============================] - 5s 49ms/step - loss: 0.0037 - sparse_categorical_acc
uracy: 0.9985 - val_loss: 1.4703 - val_sparse_categorical_accuracy: 0.6898
Epoch 43/100
97/97 [==============================] - 5s 49ms/step - loss: 0.0029 - sparse_categorical_acc
uracy: 0.9986 - val_loss: 1.4042 - val_sparse_categorical_accuracy: 0.7008
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Epoch 44/100
97/97 [==============================] - 5s 50ms/step - loss: 0.0027 - sparse_categorical_acc
uracy: 0.9989 - val_loss: 1.4559 - val_sparse_categorical_accuracy: 0.6961
Epoch 45/100
97/97 [==============================] - 5s 49ms/step - loss: 0.0026 - sparse_categorical_acc
uracy: 0.9988 - val_loss: 1.4407 - val_sparse_categorical_accuracy: 0.7000
Epoch 46/100
97/97 [==============================] - 5s 49ms/step - loss: 0.0025 - sparse_categorical_acc
uracy: 0.9986 - val_loss: 1.4674 - val_sparse_categorical_accuracy: 0.7039
Epoch 47/100
97/97 [==============================] - 5s 47ms/step - loss: 0.0023 - sparse_categorical_acc
uracy: 0.9987 - val_loss: 1.4501 - val_sparse_categorical_accuracy: 0.7016
Epoch 48/100
97/97 [==============================] - 5s 49ms/step - loss: 0.0023 - sparse_categorical_acc
uracy: 0.9988 - val_loss: 1.4741 - val_sparse_categorical_accuracy: 0.7008
Epoch 49/100
97/97 [==============================] - 5s 50ms/step - loss: 0.0024 - sparse_categorical_acc
uracy: 0.9989 - val_loss: 1.4729 - val_sparse_categorical_accuracy: 0.6992
Epoch 50/100
97/97 [==============================] - 5s 50ms/step - loss: 0.0021 - sparse_categorical_acc
uracy: 0.9989 - val_loss: 1.5245 - val_sparse_categorical_accuracy: 0.6969
Epoch 51/100
97/97 [==============================] - 5s 48ms/step - loss: 0.0023 - sparse_categorical_acc
uracy: 0.9985 - val_loss: 1.5019 - val_sparse_categorical_accuracy: 0.6961
Epoch 52/100
97/97 [==============================] - 5s 47ms/step - loss: 0.0021 - sparse_categorical_acc
uracy: 0.9986 - val_loss: 1.5094 - val_sparse_categorical_accuracy: 0.7016
Epoch 53/100
97/97 [==============================] - 5s 48ms/step - loss: 0.0018 - sparse_categorical_acc
uracy: 0.9988 - val_loss: 1.4948 - val_sparse_categorical_accuracy: 0.7063
Epoch 54/100
97/97 [==============================] - 5s 47ms/step - loss: 0.0020 - sparse_categorical_acc
uracy: 0.9988 - val_loss: 1.5086 - val_sparse_categorical_accuracy: 0.7000
Epoch 55/100
97/97 [==============================] - 5s 47ms/step - loss: 0.0017 - sparse_categorical_acc
uracy: 0.9990 - val_loss: 1.5147 - val_sparse_categorical_accuracy: 0.7000
Epoch 56/100
97/97 [==============================] - 5s 49ms/step - loss: 0.0020 - sparse_categorical_acc
uracy: 0.9986 - val_loss: 1.5173 - val_sparse_categorical_accuracy: 0.6984
Epoch 57/100
97/97 [==============================] - 5s 49ms/step - loss: 0.0019 - sparse_categorical_acc
uracy: 0.9986 - val_loss: 1.5208 - val_sparse_categorical_accuracy: 0.7055
Epoch 58/100
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97/97 [==============================] - 5s 50ms/step - loss: 0.0018 - sparse_categorical_acc
uracy: 0.9984 - val_loss: 1.5418 - val_sparse_categorical_accuracy: 0.6977
Epoch 59/100
97/97 [==============================] - 5s 47ms/step - loss: 0.0017 - sparse_categorical_acc
uracy: 0.9985 - val_loss: 1.5198 - val_sparse_categorical_accuracy: 0.6992
Epoch 60/100
97/97 [==============================] - 5s 47ms/step - loss: 0.0020 - sparse_categorical_acc
uracy: 0.9985 - val_loss: 1.5335 - val_sparse_categorical_accuracy: 0.6984
Epoch 61/100
97/97 [==============================] - 5s 49ms/step - loss: 0.0018 - sparse_categorical_acc
uracy: 0.9989 - val_loss: 1.5431 - val_sparse_categorical_accuracy: 0.6992
Epoch 62/100
97/97 [==============================] - 5s 48ms/step - loss: 0.0019 - sparse_categorical_acc
uracy: 0.9985 - val_loss: 1.5479 - val_sparse_categorical_accuracy: 0.7016
Epoch 63/100
97/97 [==============================] - 5s 50ms/step - loss: 0.0017 - sparse_categorical_acc
uracy: 0.9989 - val_loss: 1.5414 - val_sparse_categorical_accuracy: 0.7031
Epoch 64/100
97/97 [==============================] - 5s 49ms/step - loss: 0.0017 - sparse_categorical_acc
uracy: 0.9986 - val_loss: 1.5518 - val_sparse_categorical_accuracy: 0.7047
Epoch 65/100
97/97 [==============================] - 5s 49ms/step - loss: 0.0016 - sparse_categorical_acc
uracy: 0.9986 - val_loss: 1.5534 - val_sparse_categorical_accuracy: 0.7070
Epoch 66/100
97/97 [==============================] - 5s 48ms/step - loss: 0.0016 - sparse_categorical_acc
uracy: 0.9988 - val_loss: 1.5760 - val_sparse_categorical_accuracy: 0.7008
Epoch 67/100
97/97 [==============================] - 5s 47ms/step - loss: 0.0016 - sparse_categorical_acc
uracy: 0.9987 - val_loss: 1.5714 - val_sparse_categorical_accuracy: 0.6984
Epoch 68/100
97/97 [==============================] - 5s 48ms/step - loss: 0.0016 - sparse_categorical_acc
uracy: 0.9988 - val_loss: 1.5767 - val_sparse_categorical_accuracy: 0.6969
Epoch 69/100
97/97 [==============================] - 5s 48ms/step - loss: 0.0016 - sparse_categorical_acc
uracy: 0.9986 - val_loss: 1.5779 - val_sparse_categorical_accuracy: 0.7000
Epoch 70/100
97/97 [==============================] - 5s 49ms/step - loss: 0.0016 - sparse_categorical_acc
uracy: 0.9989 - val_loss: 1.5848 - val_sparse_categorical_accuracy: 0.7047
Epoch 71/100
97/97 [==============================] - 5s 48ms/step - loss: 0.0016 - sparse_categorical_acc
uracy: 0.9989 - val_loss: 1.5954 - val_sparse_categorical_accuracy: 0.7047
Epoch 72/100
97/97 [==============================] - 5s 50ms/step - loss: 0.0016 - sparse_categorical_acc
uracy: 0.9986 - val_loss: 1.6072 - val_sparse_categorical_accuracy: 0.7039
```

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Epoch 73/100
97/97 [==============================] - 5s 48ms/step - loss: 0.0016 - sparse_categorical_acc
uracy: 0.9989 - val_loss: 1.6155 - val_sparse_categorical_accuracy: 0.7000
Epoch 74/100
97/97 [==============================] - 5s 48ms/step - loss: 0.0015 - sparse_categorical_acc
uracy: 0.9989 - val_loss: 1.6227 - val_sparse_categorical_accuracy: 0.6945
Epoch 75/100
97/97 [==============================] - 5s 48ms/step - loss: 0.0017 - sparse_categorical_acc
uracy: 0.9985 - val_loss: 1.6324 - val_sparse_categorical_accuracy: 0.7008
Epoch 76/100
97/97 [==============================] - 5s 48ms/step - loss: 0.0015 - sparse_categorical_acc
uracy: 0.9989 - val_loss: 1.6335 - val_sparse_categorical_accuracy: 0.7008
Epoch 77/100
97/97 [==============================] - 5s 49ms/step - loss: 0.0015 - sparse_categorical_acc
uracy: 0.9990 - val_loss: 1.6255 - val_sparse_categorical_accuracy: 0.7000
Epoch 78/100
97/97 [==============================] - 5s 48ms/step - loss: 0.0015 - sparse_categorical_acc
uracy: 0.9985 - val_loss: 1.6280 - val_sparse_categorical_accuracy: 0.7039
Epoch 79/100
97/97 [==============================] - 5s 50ms/step - loss: 0.0016 - sparse_categorical_acc
uracy: 0.9985 - val_loss: 1.6465 - val_sparse_categorical_accuracy: 0.7031
Epoch 80/100
97/97 [==============================] - 5s 48ms/step - loss: 0.0015 - sparse_categorical_acc
uracy: 0.9990 - val_loss: 1.6607 - val_sparse_categorical_accuracy: 0.7039
Epoch 81/100
97/97 [==============================] - 5s 48ms/step - loss: 0.0016 - sparse_categorical_acc
uracy: 0.9986 - val_loss: 1.6544 - val_sparse_categorical_accuracy: 0.6977
Epoch 82/100
97/97 [==============================] - 5s 49ms/step - loss: 0.0015 - sparse_categorical_acc
uracy: 0.9987 - val_loss: 1.6414 - val_sparse_categorical_accuracy: 0.7047
Epoch 83/100
97/97 [==============================] - 5s 48ms/step - loss: 0.0015 - sparse_categorical_acc
uracy: 0.9987 - val_loss: 1.6437 - val_sparse_categorical_accuracy: 0.7063
Epoch 84/100
97/97 [==============================] - 5s 49ms/step - loss: 0.0015 - sparse_categorical_acc
uracy: 0.9986 - val_loss: 1.6535 - val_sparse_categorical_accuracy: 0.7070
Epoch 85/100
97/97 [==============================] - 5s 49ms/step - loss: 0.0015 - sparse_categorical_acc
uracy: 0.9986 - val_loss: 1.6646 - val_sparse_categorical_accuracy: 0.7055
Epoch 86/100
97/97 [==============================] - 5s 47ms/step - loss: 0.0015 - sparse_categorical_acc
uracy: 0.9989 - val_loss: 1.6840 - val_sparse_categorical_accuracy: 0.7016
Epoch 87/100
```

97/97 [==============================] - 5s 48ms/step - loss: 0.0015 - sparse_categorical_acc
uracy: 0.9989 - val_loss: 1.6940 - val_sparse_categorical_accuracy: 0.6961
Epoch 88/100
97/97 [==============================] - 5s 48ms/step - loss: 0.0015 - sparse_categorical_acc
uracy: 0.9985 - val_loss: 1.6928 - val_sparse_categorical_accuracy: 0.7078
Epoch 89/100
97/97 [==============================] - 5s 48ms/step - loss: 0.0015 - sparse_categorical_acc
uracy: 0.9988 - val_loss: 1.6909 - val_sparse_categorical_accuracy: 0.7023
Epoch 90/100
97/97 [==============================] - 5s 46ms/step - loss: 0.0015 - sparse_categorical_acc
uracy: 0.9987 - val_loss: 1.6710 - val_sparse_categorical_accuracy: 0.7094
Epoch 91/100
97/97 [==============================] - 5s 49ms/step - loss: 0.0014 - sparse_categorical_acc
uracy: 0.9991 - val_loss: 1.6835 - val_sparse_categorical_accuracy: 0.7000
Epoch 92/100
97/97 [==============================] - 5s 48ms/step - loss: 0.0016 - sparse_categorical_acc
uracy: 0.9990 - val_loss: 2.3745 - val_sparse_categorical_accuracy: 0.6133
Epoch 93/100
97/97 [==============================] - 5s 48ms/step - loss: 0.8084 - sparse_categorical_acc
uracy: 0.7455 - val_loss: 2.8483 - val_sparse_categorical_accuracy: 0.4383
Epoch 94/100
97/97 [==============================] - 5s 46ms/step - loss: 0.1783 - sparse_categorical_acc
uracy: 0.9411 - val_loss: 2.0230 - val_sparse_categorical_accuracy: 0.4992
Epoch 95/100
97/97 [==============================] - 4s 46ms/step - loss: 0.0650 - sparse_categorical_acc
uracy: 0.9802 - val_loss: 1.8194 - val_sparse_categorical_accuracy: 0.5562
Epoch 96/100
97/97 [==============================] - 5s 47ms/step - loss: 0.0188 - sparse_categorical_acc
uracy: 0.9948 - val_loss: 1.3573 - val_sparse_categorical_accuracy: 0.6781
Epoch 97/100
97/97 [==============================] - 5s 47ms/step - loss: 0.0060 - sparse_categorical_acc
uracy: 0.9985 - val_loss: 1.3944 - val_sparse_categorical_accuracy: 0.6812
Epoch 98/100
97/97 [==============================] - 5s 49ms/step - loss: 0.0027 - sparse_categorical_acc
uracy: 0.9988 - val_loss: 1.3837 - val_sparse_categorical_accuracy: 0.6953
Epoch 99/100
97/97 [==============================] - 5s 49ms/step - loss: 0.0024 - sparse_categorical_acc
uracy: 0.9986 - val_loss: 1.4230 - val_sparse_categorical_accuracy: 0.7031
Epoch 100/100
97/97 [==============================] - 5s 47ms/step - loss: 0.0022 - sparse_categorical_acc
uracy: 0.9985 - val_loss: 1.4751 - val_sparse_categorical_accuracy: 0.6898
Model: "shallow_res"

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Layer (type) Output Shape Param #

```
=================================================================
conv2d_93 (Conv2D)                multiple                  9472
_________________________________________________________________
batch_normalization_88 (Batc multiple                       256
_________________________________________________________________
activation_88 (Activation)    multiple                    0
_________________________________________________________________
max_pooling2d_28 (MaxPooling multiple                       0
_________________________________________________________________
sequential (Sequential)       (None, 4, 4, 512)         4904704
_________________________________________________________________
global_average_pooling2d_1 ( multiple                       0
_________________________________________________________________
dense_14 (Dense)              multiple                  5130
=================================================================
Total params: 4,919,562
Trainable params: 4,913,802
Non-trainable params: 5,760
_________________________________________________________________
```