




```
Model: "sequential_2"

Layer (type)                Output Shape                Param #
-----
conv2d_2 (Conv2D)           (None, 94, 94, 16)         880

max_pooling2d_2 (MaxPool2D) (None, 47, 47, 16)         0

flatten_2 (Flatten)         (None, 35344)               0

dense_4 (Dense)             (None, 16)                  565520

dense_5 (Dense)             (None, 4)                   68

Total params: 566388 (2.16 MB)
Trainable params: 566388 (2.16 MB)
Non-trainable params: 0 (0.00 Byte)

Epoch 1/30
4/4 [=====] - 2s 181ms/step - loss: 2.2590 - accuracy: 0.4024 - val_loss: 4.3007 -
val_accuracy: 0.0000e+00
Epoch 2/30
4/4 [=====] - 0s 79ms/step - loss: 1.3650 - accuracy: 0.4145 - val_loss: 1.4286 - v
al_accuracy: 0.0000e+00
Epoch 3/30
4/4 [=====] - 0s 55ms/step - loss: 1.1219 - accuracy: 0.5084 - val_loss: 1.9375 - v
al_accuracy: 0.0000e+00
Epoch 4/30
4/4 [=====] - 0s 57ms/step - loss: 0.9491 - accuracy: 0.5518 - val_loss: 2.4160 - v
al_accuracy: 0.0000e+00
Epoch 5/30
4/4 [=====] - 0s 55ms/step - loss: 0.8684 - accuracy: 0.6145 - val_loss: 2.3510 - v
al_accuracy: 0.0385
Epoch 6/30
4/4 [=====] - 0s 71ms/step - loss: 0.8393 - accuracy: 0.6434 - val_loss: 2.8791 - v
al_accuracy: 0.0441
Epoch 7/30
4/4 [=====] - 0s 57ms/step - loss: 0.7486 - accuracy: 0.7108 - val_loss: 2.1624 - v
al_accuracy: 0.0096
Epoch 8/30
4/4 [=====] - 0s 71ms/step - loss: 0.6902 - accuracy: 0.7157 - val_loss: 2.5844 - v
al_accuracy: 0.0096
Epoch 9/30
4/4 [=====] - 0s 79ms/step - loss: 0.6373 - accuracy: 0.7542 - val_loss: 2.6255 - v
al_accuracy: 0.0096
Epoch 10/30
4/4 [=====] - 0s 73ms/step - loss: 0.5819 - accuracy: 0.7735 - val_loss: 2.5092 - v
al_accuracy: 0.0192
Epoch 11/30
4/4 [=====] - 0s 72ms/step - loss: 0.5445 - accuracy: 0.7880 - val_loss: 2.4025 - v
al_accuracy: 0.0192
Epoch 12/30
4/4 [=====] - 0s 65ms/step - loss: 0.5005 - accuracy: 0.8169 - val_loss: 2.5687 - v
al_accuracy: 0.0192
Epoch 13/30
4/4 [=====] - 0s 73ms/step - loss: 0.4539 - accuracy: 0.8241 - val_loss: 2.7038 - v
al_accuracy: 0.0096
Epoch 14/30
4/4 [=====] - 0s 70ms/step - loss: 0.4181 - accuracy: 0.8361 - val_loss: 2.7143 - v
al_accuracy: 0.0096
Epoch 15/30
4/4 [=====] - 0s 67ms/step - loss: 0.3929 - accuracy: 0.8410 - val_loss: 3.0162 - v
al_accuracy: 0.0000e+00
Epoch 16/30
4/4 [=====] - 0s 61ms/step - loss: 0.3681 - accuracy: 0.8530 - val_loss: 2.9070 - v
al_accuracy: 0.0000e+00
Epoch 17/30
4/4 [=====] - 0s 69ms/step - loss: 0.3426 - accuracy: 0.8578 - val_loss: 2.9218 - v
al_accuracy: 0.0000e+00
Epoch 18/30
4/4 [=====] - 0s 68ms/step - loss: 0.3142 - accuracy: 0.8699 - val_loss: 3.2779 - v
al_accuracy: 0.0000e+00
Epoch 19/30
4/4 [=====] - 0s 65ms/step - loss: 0.2899 - accuracy: 0.8795 - val_loss: 3.0546 - v
al_accuracy: 0.0096
Epoch 20/30
4/4 [=====] - 0s 72ms/step - loss: 0.2771 - accuracy: 0.8867 - val_loss: 3.1560 - v
al_accuracy: 0.0000e+00
Epoch 21/30
4/4 [=====] - 0s 61ms/step - loss: 0.2582 - accuracy: 0.8771 - val_loss: 3.6820 - v
al_accuracy: 0.0000e+00
Epoch 22/30
4/4 [=====] - 0s 61ms/step - loss: 0.2447 - accuracy: 0.8867 - val_loss: 3.5167 - v
al_accuracy: 0.0000e+00
Epoch 23/30
4/4 [=====] - 0s 73ms/step - loss: 0.2270 - accuracy: 0.8988 - val_loss: 3.5220 - v
al_accuracy: 0.0000e+00
Epoch 24/30
4/4 [=====] - 0s 77ms/step - loss: 0.2141 - accuracy: 0.8988 - val_loss: 3.7327 - v
al_accuracy: 0.0000e+00
Epoch 25/30
4/4 [=====] - 0s 85ms/step - loss: 0.2035 - accuracy: 0.9012 - val_loss: 3.7770 - v
al_accuracy: 0.0000e+00
Epoch 26/30
4/4 [=====] - 0s 92ms/step - loss: 0.1968 - accuracy: 0.9012 - val_loss: 3.6964 - v
al_accuracy: 0.0000e+00
Epoch 27/30
4/4 [=====] - 0s 66ms/step - loss: 0.1874 - accuracy: 0.9205 - val_loss: 3.3799 - v
al_accuracy: 0.0000e+00
Epoch 28/30
4/4 [=====] - 0s 60ms/step - loss: 0.1797 - accuracy: 0.9205 - val_loss: 3.7220 - v
al_accuracy: 0.0000e+00
Epoch 29/30
4/4 [=====] - 0s 57ms/step - loss: 0.1713 - accuracy: 0.9108 - val_loss: 4.0325 - v
al_accuracy: 0.0000e+00
Epoch 30/30
4/4 [=====] - 0s 60ms/step - loss: 0.1636 - accuracy: 0.9108 - val_loss: 3.7494 - v
al_accuracy: 0.0000e+00

Test loss: 1.6819171905517578
Test accuracy: 0.5875757503509521
```

```
In [27]: def plot_new_curve_2():
plt.plot(history_2.history["accuracy"], label="Training Accuracy")
plt.plot(history_2.history["val_accuracy"], label="Validation Accuracy")
plt.xlabel("Number of epochs")
plt.ylabel("Training and validation accuracy")
plt.title("Learning curve for 7x7")
plt.grid(True)
plt.show()

plot_new_curve_2()
```



The model with the 3x3 filter size has the best accuracy with 57%, while the 5x5 model has the lowest with 45%. Additionally, the 5x5 model has the highest test loss with 2.18 while the 3x3 has the lowest with 1.65. Overall, all the models are underfitting since their accuracy 57%, 45% and 51% for 3x3, 5x5 and 7x7 respectively.