

● CNN 모델 구조 summary

Model: "sequential_3"

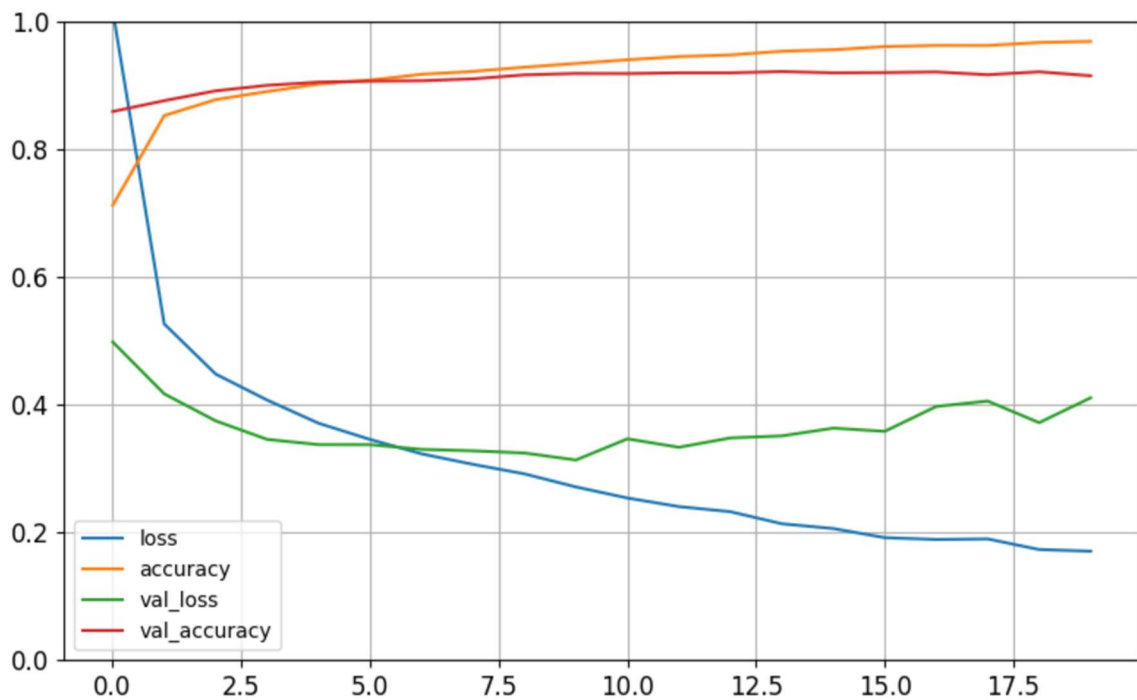
Layer (type)	Output Shape	Param #
batch_normalization_3 (Batch Normalization)	(None, 28, 28, 1)	4
conv2d_15 (Conv2D)	(None, 28, 28, 64)	3200
max_pooling2d_9 (MaxPooling2D)	(None, 14, 14, 64)	0
conv2d_16 (Conv2D)	(None, 14, 14, 128)	73856
conv2d_17 (Conv2D)	(None, 14, 14, 128)	147584
max_pooling2d_10 (MaxPooling2D)	(None, 7, 7, 128)	0
conv2d_18 (Conv2D)	(None, 7, 7, 256)	295168
conv2d_19 (Conv2D)	(None, 7, 7, 256)	590080
max_pooling2d_11 (MaxPooling2D)	(None, 3, 3, 256)	0
global_average_pooling2d_3 (GlobalAveragePooling2D)	(None, 256)	0
dense_9 (Dense)	(None, 128)	32896
dropout_7 (Dropout)	(None, 128)	0
dense_10 (Dense)	(None, 64)	8256
dropout_8 (Dropout)	(None, 64)	0
dense_11 (Dense)	(None, 10)	650
Total params: 1151694 (4.39 MB)		
Trainable params: 1151692 (4.39 MB)		
Non-trainable params: 2 (8.00 Byte)		

● Epochs 11~20 로그

```
Epoch 11/20
1719/1719 [=====] - 17s 10ms/step - loss: 0.2540 - accuracy: 0.9402 - val_loss: 0.3467 - val_accuracy: 0.9186
Epoch 12/20
1719/1719 [=====] - 17s 10ms/step - loss: 0.2406 - accuracy: 0.9453 - val_loss: 0.3334 - val_accuracy: 0.9198
Epoch 13/20
1719/1719 [=====] - 17s 10ms/step - loss: 0.2326 - accuracy: 0.9478 - val_loss: 0.3481 - val_accuracy: 0.9198
Epoch 14/20
1719/1719 [=====] - 17s 10ms/step - loss: 0.2137 - accuracy: 0.9536 - val_loss: 0.3513 - val_accuracy: 0.9218
Epoch 15/20
1719/1719 [=====] - 17s 10ms/step - loss: 0.2062 - accuracy: 0.9560 - val_loss: 0.3634 - val_accuracy: 0.9198
Epoch 16/20
1719/1719 [=====] - 17s 10ms/step - loss: 0.1919 - accuracy: 0.9609 - val_loss: 0.3584 - val_accuracy: 0.9202
Epoch 17/20
1719/1719 [=====] - 17s 10ms/step - loss: 0.1891 - accuracy: 0.9627 - val_loss: 0.3973 - val_accuracy: 0.9212
Epoch 18/20
1719/1719 [=====] - 17s 10ms/step - loss: 0.1899 - accuracy: 0.9626 - val_loss: 0.4058 - val_accuracy: 0.9168
Epoch 19/20
1719/1719 [=====] - 17s 10ms/step - loss: 0.1733 - accuracy: 0.9673 - val_loss: 0.3720 - val_accuracy: 0.9214
Epoch 20/20
1719/1719 [=====] - 17s 10ms/step - loss: 0.1707 - accuracy: 0.9691 - val_loss: 0.4109 - val_accuracy: 0.9152
313/313 [=====] - 2s 5ms/step - loss: 0.4121 - accuracy: 0.9149
1/1 [=====] - 0s 161ms/step
```

● CNN 모델 훈련 그래프 (Epochs : 20)

그림 저장 keras_learning_curves_plot



● 테스트 데이터 평가

```
313/313 [=====] - 1s 4ms/step - loss: 0.4121 - accuracy: 0.9149
Training Loss: 0.1707400530576706
Training Accuracy: 0.969072699546814
Validation Loss: 0.4109172224998474
Validation Accuracy: 0.9151999950408936
```