

CNN models for image classification – ML Assignement_4

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The five sea animals used for the classification task are (Classes): ['Otter', 'Sea Urchins', 'Seal', 'Sharks', 'Turtle_Tortoise']

Task1 Model 1:

| Model: "sequential" | | |
|--------------------------------|---------------------|---------|
| Layer (type) | Output Shape | Param # |
| rescaling (Rescaling) | (None, 100, 100, 3) | 0 |
| conv2d (Conv2D) | (None, 98, 98, 32) | 896 |
| max_pooling2d (MaxPooling2D) | (None, 49, 49, 32) | 0 |
| dropout (Dropout) | (None, 49, 49, 32) | 0 |
| conv2d_1 (Conv2D) | (None, 47, 47, 64) | 18496 |
| max_pooling2d_1 (MaxPooling2D) | (None, 23, 23, 64) | 0 |
| dropout_1 (Dropout) | (None, 23, 23, 64) | 0 |
| conv2d_2 (Conv2D) | (None, 21, 21, 128) | 73856 |
| max_pooling2d_2 (MaxPooling2D) | (None, 10, 10, 128) | 0 |
| dropout_2 (Dropout) | (None, 10, 10, 128) | 0 |
| flatten (Flatten) | (None, 12800) | 0 |
| dense (Dense) | (None, 128) | 1638528 |
| dropout_3 (Dropout) | (None, 128) | 0 |
| dense_1 (Dense) | (None, 5) | 645 |
| Total params: 1,732,421 | | |
| Trainable params: 1,732,421 | | |
| Non-trainable params: 0 | | |

Layer 1: The input layer gets the vectorized image. The number of nodes is 32, kernel of size 3*3, activation function: Relu

Layer 2: Pooling layer of size 2*2
The drop out is 0.2

Layer 3: Convolution layer with kernel of size 3*3, number of nodes: 64, activation function: Relu

Layer 4: Pooling layer of size 2*2

The drop out is 0.2

Layer 5: Convolution layer with kernel of size 3*3, number of nodes: 128, activation function: Relu

Layer 6: Pooling layer of size 2*2

The drop out is 0.2

Layer 7: Flattened layer with 128 nodes, activation function: Relu

Layer 8: Output layer with softmax activation and 5 nodes.

There are 1732421 weights learned as part of training.

Task1 Model 2:

Model: "sequential"

| Layer (type) | Output Shape | Param # |
|--------------------------------|---------------------|---------|
| rescaling (Rescaling) | (None, 100, 100, 3) | 0 |
| conv2d (Conv2D) | (None, 98, 98, 32) | 896 |
| max_pooling2d (MaxPooling2D) | (None, 49, 49, 32) | 0 |
| dropout (Dropout) | (None, 49, 49, 32) | 0 |
| conv2d_1 (Conv2D) | (None, 46, 46, 128) | 65664 |
| max_pooling2d_1 (MaxPooling2D) | (None, 15, 15, 128) | 0 |
| dropout_1 (Dropout) | (None, 15, 15, 128) | 0 |
| conv2d_2 (Conv2D) | (None, 12, 12, 128) | 262272 |
| max_pooling2d_2 (MaxPooling2D) | (None, 6, 6, 128) | 0 |
| dropout_2 (Dropout) | (None, 6, 6, 128) | 0 |
| flatten (Flatten) | (None, 4608) | 0 |
| dense (Dense) | (None, 64) | 294976 |
| dropout_3 (Dropout) | (None, 64) | 0 |
| dense_1 (Dense) | (None, 5) | 325 |

Total params: 624,133

Trainable params: 624,133

Non-trainable params: 0

Layer 1: The input layer gets the vectorized image. The number of nodes is 32, kernel of size 3*3, activation function: Relu

Layer 2: Pooling layer of size 2*2

The dropout is 0.1.

Layer 3: Convolution layer with kernel of size 4*4, number of node: 128, activation function : Relu

Layer 4: Pooling layer of size 3*3

The drop out is 0.2.

Layer 5: Convolution layer with kernel of size 4*4, number of node: 128, activation function: Relu

Layer 6: Pooling layer of size 3*3

The drop out is 0.3.

Layer 7: Flattened layer with 64 nodes, activation function: Relu

The drop out is 0.2.

Layer 8: Output layer with softmax activation and 5 nodes.

There are 624,133 weights learned as part of training.

Question: 2 Training time and accuracy of CNN models:

The model my_cnn.h5 took 44 epochs to converge. The training accuracy is 0.98. The training accuracy improved from 0.55 to 0.98.

The model my_cnn2.h5 took 32 epochs to converge. The training accuracy is 0.944. The training accuracy improved from 0.54 to 0.96.

The vgg model my_fine_tuned.h5 took 15 epochs to converge. The training accuracy is 0.99. The training accuracy improved from 0.82 to 0.99.

Question: 3 Evaluation of the CNN models:

| S.No | Details | My_cnn | My_cnn2 | My_fine_tuned |
|------|----------------|--------|---------|---------------|
| 1 | Test accuracy | 0.81 | 0.83 | 0.89 |
| 2 | Train accuracy | 0.98 | 0.96 | 0.99 |
| 3 | No of Epochs | 44 | 32 | 15 |

The fine turned vgg achieved the highest accuracy of 0.89 on the test set. The fine turned vgg also converges faster than the own architecture cnns. The fine turned vgg took more time for each epoch because of the higher configuration.

The own architecture cnns my_cnn and my_cnn2 performed with test accuracies of 0.81 and 0.83 respectively.

Question 4: Error Analysis

My_cnn2 and my_fine_tuned are used for the error analysis task.

5 images of the 'Otter', 'Turtle_Tortoise', 'Sea Urchins', 'Sharks' were used for the task.

Please find the prediction results below:

Class details: 0: Otter, 1: Sea Urchin, 2: Seal, 3: Sharks, 4: Turtle_Tortoise

Otters Images Used



Class 0: “Otter”

| Image | My_cnn2 | My_fine_tuned |
|-------|---------|---------------|
| o1 | 0 | 0 |
| o2 | 0 | 4 |
| o3 | 0 | 0 |
| o4 | 4 | 0 |
| o5 | 2 | 4 |

Result: Both my_cnn2 and my_fine_tuned predicted otters correctly in images 1 and 3. My_cnn2 predicted otter correctly in image 2 and my_fine_tuned predicted otter correctly in image 4. Both failed to predict the otter in image 5.

Class 1: “Sea Urchin”

Sea-Urchin Images Used



| S.no | My_cnn2 | My_fine_tuned |
|------|---------|---------------|
| su1 | 1 | 1 |
| su2 | 1 | 1 |
| su3 | 1 | 1 |

| | | |
|-----|---|---|
| su4 | 1 | 1 |
| su5 | 1 | 1 |

Result: Both my_cnn2 and my_fine_turned predicted sea urchins correctly in all 5 images.

Class 3: “Sharks”



| Image | My_cnn2 | My_fine_turned |
|-------|---------|----------------|
| sh1 | 3 | 3 |
| sh2 | 3 | 4 |
| sh3 | 4 | 4 |
| sh4 | 3 | 3 |
| sh5 | 4 | 3 |

Result: Both my_cnn2 and my_fine_turned predicted otters correctly in images 1 and 4. My_cnn2 predicted otter correctly in image 2 and my_fine_turned predicted otter correctly in image 5. Both failed to predict the sharks in image 3.

Class 4: “Turtle_Tortoise”



| Image | My_cnn2 | My_fine_turned |
|-------|---------|----------------|
| t1 | 4 | 4 |
| t2 | 4 | 4 |
| t3 | 4 | 4 |
| t4 | 4 | 4 |
| t5 | 4 | 4 |

Result: Both my_cnn2 and my_fine_turned predicted sea urchins and turtle_tortoise correctly in all 5 images. For sharks, both classified 3/5 images.

