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Assignment 4

Due Date: Monday Nov 14, right before midnight .

Please submit the pdf printouts to the teacher during class.

To save paper, please cut away the text cells. (Select the explanations part of the notebook, then click the scissors icon below the menu bar.) **Submit only the computation cells and their results in your pdf.**

(0) Run Chollet's code 5.1-IntroToConvnet. As usual, have your code print out your name and student ID in the first cell.

See Chollet5.1_IntroConvnet.pptx, in iSpace Chollet > Chollet PPT. In the code's output, compare the number of parameters in your run with that in Chollet5.1_IntroConvnet.pptx. **Print out the notebook as a pdf** . You will need to use it for part (2).

Remember to remove the explanation cells from your notebook before you run your code. Submit only the computation cells and their results.

Fill in the missing info. In the Comments columns, compute the outside size by using the formula, similar to those for layer 1 in Chollet5.1_IntroConvnet.pptx.

Layer	**Output shape**	**Param #**	**Comments**
connv2d_2	(None, 11, 11, 64)	18496	$(n+2p-f)/s+1 = (13+0-3)/1+1 = 11$ → output size $3\times3\times32\times64+64 = 18496$ → param
maxpooling2_2	(None, 5, 5, 64)	0	$(n+2p-f)/s+1 = (11+0-2)/2+1 \doteq 5$ → output size
conv2d_3	(None, 3, 3, 64)	36928	$(n+2p-f)/s+1 = (5+0-3)/1+1 = 3$ → output size $3\times3\times64\times64+64 = 36928$ → param

(1) Slightly modify the code Code 5.1-IntroToConvnet.

As usual, have your jupyter notebook print out your name and student ID in the first cell.

(a) Use Average Pool rather than Max Pool:

model.add(layers.AveragePooling2D((2,2)))

(b) In the FC (dense) layer, use 32 nodes instead of 64.

Notice the accuracy and the number of parameters are changed. After these changes, rerun the entire code in sequence using Kernel > Restart and Run All.

Print the notebook and results as a pdf file. In your pdf file, **circle the accuracy** and how the **number of parameters** are changed from part (0). **Submit the printout**.

(2) Compare the total number of parameters in the convnet model in part (0) with the densely connected model you ran in Assignment 2 (Code 2.1_Mnist). Rerun your Assignment 2 code. If need be, add lines to the code to show the number of parameters in the model. On the **printout pdf for part (1)**, **circle the total number of parameters**. Write down the corresponding number of parameters for the densely connected model from Assignment 2.

Please do parts (3) and (4) on a piece of paper and submit it to the teacher.

(3) Compare the model's architectures in Ng (C4M1_CNN.pptx, L10) versus the code you ran in (0) (Chollet5.1_IntroConvnets.pptx).

(a) The first difference between the two architectures is the size of the input image. How are the input sizes different?

The (0) input size is (28, 28, 1). The Ng's input size is (32, 32, 3)

(b) What is the second difference between the two architectures?

The Ng's kernel size is (5, 5). Ours kernel size is (3, 3)

(4) Consider the convolution

1	2	3	4
5	6	7	8
9	10	11	12
13	14	15	16

(4x4x1)

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-2	-2	-2
0	0	0
1	1	1

(3x3x1)

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(4a) What is the size of the output, i.e. how many rows and columns? Assume p=0, s=1.

$(4+0-3)/1 + 1 = 2 \Rightarrow$ 2 rows, 2 columns.

(4b) Compute the output for the convolution.

The output is

18	15
6	3

(4c) Supposed we use stride = 2 and padding = 1. What is the output size?

$(4+2-3)/2 + 1 \approx 2$ output size is: 2 rows, 2 columns

(4d) Compute the output for the convolution with stride=2 and padding=1.

The output is

11	21
5	0

(4e) Supposed we perform a maxpool on the original 4 x 4 image, with f = 3 and s =1.

Compute the output.

Output size: $(4+0-3)/1 + 1 = 2$.

The output is

11	12
15	16

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(5) How many parameters are in a CONV layer, if the input for the layer is 64x64x4, and the activation shape is 32x32x10, with f=5. Consider both the weights and biases.

$5 \times 5 \times 4 \times 10 + 10 = 1010$

There are 1010 parameters in a CONV Layer.