CSC 578 HW6

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1. **Convolutional layer volume**

W2, H2, D2:

W2 = (W1 – F + 2P)/S + 1

H2 = (H1 – F + 2P)/S + 1

D2 = K

From the reading material from Stanford, to calculate how many neurons “fit” is given by (W-F+2P)/S+1, and the width(W) = height(H) and the depth(D) will stay the same, therefore we can get the formulas for W2 and H2.

1. **Volume calculation example**

Input size 32x32, 100 filters, filter size 3x3, stride =1, depth = 1

1. The size of feature map (including depth):

(32 – 3)/1 + 1 = 30

Therefore, the feature map: 30x30x100 = 90000

1. The total number of parameters

(3\*3\*1+1)\*100 = 1000

1. **Convolution filter application**

A.

**1.** 0\*1+0\*1+0\*-1+0\*-1+0\*1+2\*1+2\*-1+2\*-1+0\*1+2\*1+2\*-1+2\*-1+0\*1+2\*1+2\*-1+2\*-1 = -6

**2.** 0\*1+0\*1+0\*-1+0\*-1+2\*1+2\*1+2\*-1+0\*-1+2\*1+2\*1+2\*-1+0\*-1+2\*1+2\*1+2\*-1+0\*-1 = 6

**3.** 0\*1+0\*1+0\*-1+0\*-1+2\*1+2\*1+0\*-1+0\*-1+2\*1+2\*1+0\*-1+0\*-1+2\*1+2\*1+0\*-1+0\*-1 = 12

**4.** 0\*1+2\*1+2\*-1+2\*-1+0\*1+2\*1+2\*-1+2\*-1+0\*1+2\*1+2\*-1+2\*-1+0\*1+0\*1+0\*-1+0\*-1 = -6

**5.** 2\*1+2\*1+2\*-1+0\*-1+2\*1+2\*1+2\*-1+0\*-1+2\*1+2\*1+2\*-1+0\*-1+0\*1+0\*1+0\*-1+0\*-1 = 6

**6.** 2\*1+2\*1+0\*-1+0\*-1+2\*1+2\*1+0\*-1+0\*-1+2\*1+2\*1+0\*-1+0\*-1+0\*1+0\*1+0\*-1+0\*-1 = 12

**7.** 0\*1+2\*1+2\*-1+2\*-1+0\*1+2\*1+2\*-1+2\*-1+0\*1+0\*1+0\*-1+0\*-1+0\*1+0\*1+0\*-1+0\*-1 = -4

**8.** 2\*1+2\*1+2\*-1+0\*-1+2\*1+2\*1+2\*-1+0\*-1+0\*1+0\*1+0\*-1+0\*-1+0\*1+0\*1+0\*-1+0\*-1 = 4

**9.** 2\*1+2\*1+0\*-1+0\*-1+2\*1+2\*1+0\*-1+0\*-1+0\*1+0\*1+0\*-1+0\*-1+0\*1+0\*1+0\*-1+0\*-1 = 8

|  |  |  |
| --- | --- | --- |
| -6 | 6 | 12 |
| -6 | 6 | 12 |
| -4 | 4 | 8 |

B.

With the stride = 1, the image focuses mainly on the top left corner since the 2’s are present mainly on the top left corner and show brighter color.

1. **Padding**

Input = 7x7, filter 3x3, stride = 2, output 3x3, depth 1

(7 + 2P – 3)/2 + 1 = 7, therefore, P = 4

So the padding size is 4x4.

1. **CNN Parameters**

Input: 32x32x3: 32 wide, 32 high, 3 color channels

**[1st layer]** Convolution – 32 5x5 filters, stride (1,1), activation ReLU

conv2d\_1 (Conv2D) (None, 28, 28, 32) 2432

param # for each filter: (5\*5\*3)+1 = 76

param # for all: 32\*76 = 2432 = param #

**[2nd layer]** Max pooling – size 2x2, stride (2,2)

max\_pooling2d\_1 (MaxPooling2 (None, 14, 14, 32) 0

The max\_pooling layer will reduce the number of parameters, operate independently on every depth slice of the input, and resizes it spatially, using the MAX operation; therefore, no param #.

**[3rd layer]** Convolution – 32 5x5 filters, stride (1,1), activation ReLU

conv2d\_2 (Conv2D) (None, 10, 10, 32) 25632

param # for each filter: (5\*5\*32)+1 = 801

param # for all: 801\*32 = 25632 = param #

**[4th layer]** Max pooling – size 2x2, stride (2,2)

max\_pooling2d\_2 (MaxPooling2 (None, 5, 5, 32) 0

The max\_pooling layer will reduce the number of parameters, operate independently on every depth slice of the input, and resizes it spatially, using the MAX operation; therefore, no param #.

**[5th layer]** Fully connected (Dense) – 512 nodes, activation ReLU

dense\_1 (Dense) (None, 512) 410112

(800+1) \* 512 = 410112 = param #

**[6th layer]** Fully connected (Dense) – 10 nodes, activation Softmax

dense\_2 (Dense) (None, 10) 5130

(512+1) \* 10 = 5130

Total params: 443,306

2432+0+25632+0+0+410112+5130 = 443306 = total params