Problem Set 2

4. Model Size

(a) Input to hidden layer 1:

= (No. of inputs) × (no. of hidden nodes in layer 1)

= 32 × 32 × 10

= 10240

Hidden layer 1 to hidden layer 2:

= (no. of nodes in layer 1) × (no. of nodes in layer 2)

= 10 × 10

= 100.

Hidden layer 2 to hidden layer 3 :

$= 10 \times 10$

$= 100$

Hidden layer 3 to hidden layer 4 :

$= 10 \times 10$

$= 100$

Hidden layer 4 to hidden layer 5 :

$= 10 \times 10$

$= 100$

Hidden layer 5 to output layer :

$= (\text{no. of hidden nodes in layer 5}) \times (\text{no. of output nodes})$

$= 10 \times 100$

$= 1000$

∴ Total no. of weights

$= 10240 + 100 + 100 + 100 + 100 + 1000$

$= \boxed{11640}$

Number of biases

$= (10 \times 5) + 100$

$= \boxed{150}$

∴ Total parameters $= 11640 + 150$

$= \boxed{11790}$

Ans

(b) No. of learnable parameters in CNN =

input × output + biases

if last layer is dense, input = # of nodes

if last layer is conv., input = # of filters

(# of filters) × (size of filters)

# of filters

Input = $32 \times 32 \times 3$

All conv. layers have 5 3×3 filters.

No. of parameters b/w input layer & hidden layer 1:

Weights = $3 \times 5 \times 3 \times 3 = 135$

Biases = 5

$\therefore$ Total = 140.

No. of parameters b/w hidden layer 1 & hidden layer 2:

Weights = $5 \times 5 \times 3 \times 3$

= 225

Biases = 5

∴ Total = 230

No. of parameters b/w hidden layer 2 & hidden layer 3:

Weights = $5 \times 5 \times 3 \times 3$

= 225

Biases = 5

∴ Total = 230

Similarly, no. of parameters b/w layers 3 & 4 and layers 4 & 5 will be 230.

No. of parameters b/w hidden layer 5 & output layer:

(We assume zero padding, ∴ size of input remains the same)

We flatten the output from the last conv. layer.

∴ No. of weights = $32 \times 32 \times 5$

$= 5120 \times 100$

$= 512000$

No. of biases = 100

∴ Total = 512100

∴ Total learnable parameters =

$140 + (230 \times 4) + 512100$

$= \boxed{513160}$ Ans

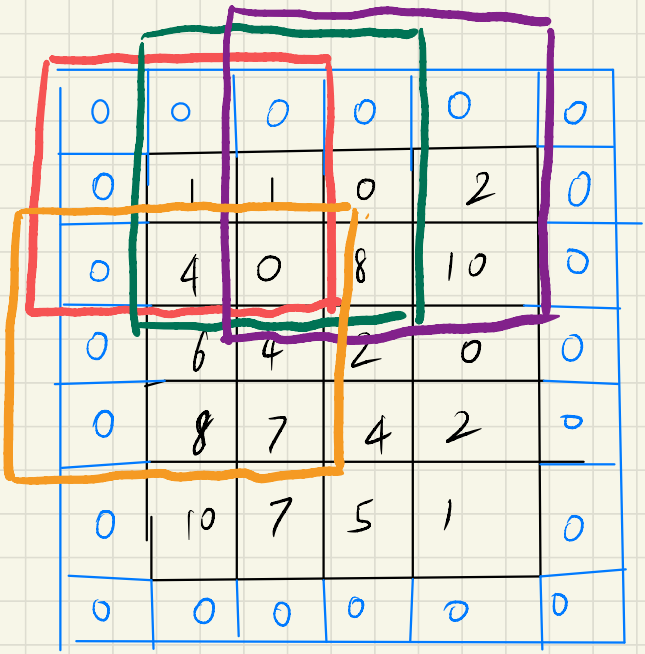
5.) (c)

1	1	0	2
4	0	8	10
6	4	2	0
8	7	4	2
10	7	5	1

The filter size is 3×3.

$\therefore$ for SAME padding : $p = \frac{3-1}{2} = 1$

0	0	0	0	0	0
0	1	1	0	2	0
0	4	0	8	10	0
0	6	4	2	0	0
0	8	7	4	2	0
0	10	7	5	1	0
0	0	0	0	0	0



$0 \cdot 5 + 2 + 4 + 2$

$*$

0	0.5	0
0.5	1	0.5
0	0.5	0

4

after convolution with filter

3.5	1.5	5.5	7
7.5	8.5	14	15
12	11.5	10	7
15.5	18.5	12	4.5
17.5	18	12	4.5

The output dimension remain consistent. (5×4)

d.)

1	1	0	2
4	0	8	10
6	4	2	0
8	7	4	2
10	7	5	1

Data type 1: Input

0	0.5	0
0.5	1	0.5
0	0.5	0

Data type 2: Filter

9.5	15
18.5	4.5

← Any