Name Waqar Kaleem Khan

Assignment no 2

Date 09/04/2020

Course Deep learning

Class MSDS

Enrollment no 01-249191-013

Instructor Dr Imran Siddiqi

Note: Sir my laptop screen(display) is fluctuating because of VGA cable issue so I was not able to do my assignment in world or excel that's why I have done my assignment by hand so please accept it as you know because of lockdown I am also not able to repair it. Thanks

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Filter F1 according to enrolment no

$A = \begin{bmatrix} 2 & 4 & 9 \\ 1 & 9 & 1 \\ 0 & 1 & 3 \end{bmatrix}$ $B = \begin{bmatrix} 3 & 1 & 0 \\ 1 & 9 & 1 \\ 9 & 4 & 2 \end{bmatrix}$ $C = A - B = \begin{bmatrix} -1 & 3 & 9 \\ 0 & 0 & 0 \\ -9 & -3 & 1 \end{bmatrix}$

Now Applying F1 to image

$R = \begin{bmatrix} 1 & 0 & 1 & 0 & 2 & 0 \\ 2 & 1 & 1 & 0 & 2 & 1 \\ 1 & 0 & 1 & 0 & 1 & 2 \\ 2 & 1 & 2 & 0 & 1 & 0 \\ 1 & 0 & 2 & 0 & 2 & 1 \\ 2 & 1 & 2 & 0 & 2 & 2 \end{bmatrix}$

$A = \begin{bmatrix} 2 & 4 & 9 \\ 1 & 9 & 1 \\ 0 & 1 & 3 \end{bmatrix}$

$R_{A11} = (2\times1 + 4\times0 + 9\times1) + (1\times2 + 9\times1 + 1\times1) + (0\times1 + 1\times0 + 3\times1) = 26$

$R_{A12} = (2\times0 + 4\times1 + 9\times0) + (1\times1 + 9\times1 + 1\times0) + (0\times0 + 1\times1 + 3\times0) = 15$

$R_{A13} = (2\times1 + 4\times0 + 9\times2) + (1\times1 + 9\times0 + 1\times2) + (0\times1 + 1\times0 + 3\times1) = 24$

$R_{A14} = (2\times0 + 4\times2 + 9\times0) + (1\times0 + 9\times2 + 1\times1) + (0\times0 + 1\times1 + 3\times2) = 34$

(2)

$RA_{21} = (2\times2 + 4\times1 + 9\times1) + (1\times1 + 9\times0 + 1\times1) + (0\times2 + 1\times1 + 3\times2) = 26$

$RA_{22} = (2\times1 + 4\times1 + 9\times0) + (1\times0 + 9\times1 + 1\times0) + (0\times1 + 1\times2 + 3\times0) = 17$

$RA_{23} = (2\times1 + 4\times0 + 9\times2) + (1\times1 + 9\times0 + 1\times1) + (0\times2 + 1\times0 + 3\times1) = 25$

$RA_{24} = (2\times0 + 4\times2 + 9\times1) + (1\times0 + 9\times1 + 1\times2) + (0\times0 + 1\times1 + 3\times0) = 29$

$RA_{31} = (2\times1 + 4\times0 + 9\times1) + (1\times2 + 9\times1 + 1\times2) + (0\times1 + 1\times0 + 3\times2) = 30$

$RA_{32} = (2\times0 + 4\times1 + 9\times0) + (1\times1 + 9\times2 + 1\times0) + (0\times0 + 1\times2 + 3\times0) = 25$

$RA_{33} = (2\times1 + 4\times0 + 9\times1) + (1\times2 + 9\times0 + 1\times1) + (0\times2 + 1\times0 + 3\times2) = 20$

$RA_{34} = (2\times0 + 4\times1 + 9\times2) + (1\times0 + 9\times1 + 1\times0) + (0\times0 + 1\times2 + 3\times1) = 36$

$RA_{41} = (2\times2 + 4\times1 + 9\times2) + (1\times1 + 9\times0 + 1\times2) + (0\times2 + 1\times1 + 3\times2) = 32$

$RA_{42} = (2\times1 + 4\times2 + 9\times0) + (1\times0 + 9\times2 + 1\times0) + (0\times1 + 1\times2 + 3\times0) = 30$

$RA43 = (2\times2 + 4\times0 + 9\times1) + (1\times2 + 9\times0 + 1\times2) + (0\times2 + 1\times0 + 3\times2) = 23$

$RA44 = (2\times0 + 4\times1 + 9\times0) + (1\times0 + 9\times2 + 1\times1) + (0\times0 + 1\times2 + 3\times2) = 31$

R conv A =

26	15	24	34
26	17	25	29
30	25	20	36
32	30	23	31

Now G conv B

3	1	0	1	0	2
2	2	2	0	2	1
3	3	3	1	0	3
2	3	0	0	1	3
3	3	3	1	0	1
2	1	2	0	2	2

con

3	1	0
1	9	1
9	4	2

$GB11 = (3\times3 + 1\times1 + 0\times0) + (1\times2 + 9\times2 + 1\times2) + (9\times3 + 4\times3 + 2\times3) = 77$

$GB12 = (3\times1 + 1\times0 + 0\times1) + (1\times2 + 9\times2 + 1\times0) + (9\times3 + 4\times3 + 2\times1) = 64$

$GB13 = (3\times0 + 1\times1 + 0\times0) + (1\times2 + 9\times0 + 1\times2) + (9\times3 + 4\times1 + 2\times0) = 36$

$GB14 = (3\times1 + 1\times0 + 0\times2) + (1\times0 + 9\times2 + 1\times1) + (9\times1 + 4\times0 + 2\times3) = 37$

$GB_{21} = (3\times2 + 1\times2 + 0\times2) + (1\times3 + 9\times3 + 1\times3) + (9\times2 + 4\times3 + 2\times0) = 71$

$GB_{22} = (3\times2 + 1\times2 + 0\times0) + (1\times3 + 9\times3 + 1\times1) + (9\times3 + 4\times0 + 2\times0) = 66$

$GB_{23} = (3\times2 + 1\times0 + 0\times2) + (1\times3 + 9\times1 + 1\times0) + (9\times0 + 4\times0 + 2\times1) = 20$

$GB_{24} = (3\times0 + 1\times2 + 0\times1) + (1\times1 + 9\times0 + 1\times3) + (9\times0 + 4\times1 + 2\times3) = 15$

$GB_{31} = (3\times3 + 1\times3 + 0\times3) + (1\times2 + 9\times3 + 1\times0) + (9\times3 + 4\times3 + 2\times3) = 86$

$GB_{32} = (3\times3 + 1\times3 + 0\times1) + (1\times3 + 9\times0 + 1\times0) + (9\times3 + 4\times3 + 2\times1) = 56$

$GB_{33} = (3\times3 + 1\times1 + 0\times0) + (1\times0 + 9\times0 + 1\times1) + (9\times3 + 4\times1 + 2\times0) = 42$

$GB_{34} = (3\times1 + 1\times0 + 0\times3) + (1\times0 + 9\times1 + 1\times3) + (9\times1 + 4\times0 + 2\times1) = 26$

$GB_{41} = (3\times2 + 1\times3 + 0\times0) + (1\times3 + 9\times3 + 1\times3) + (9\times2 + 4\times1 + 2\times2) = 68$

G_{B42} $(3\times3 + 1\times0 + 0\times0) + (1\times3 + 9\times3 + 1\times1) + (9\times1 + 4\times2 + 2\times0) = 57$

G_{B43} $(3\times0 + 1\times0 + 0\times1) + (1\times3 + 9\times1 + 1\times0) + (9\times2 + 4\times0 + 2\times2) = 34$

G_{B44} $(3\times0 + 1\times1 + 0\times3) + (1\times1 + 9\times0 + 1\times1) + (9\times0 + 4\times2 + 2\times2) = 15$

G conv B =

77	64	36	37
71	66	20	15
86	56	42	26
68	57	34	15

Now B conv C

0	1	3	0	1	3
2	0	0	2	0	0
0	1	3	0	1	3
2	0	0	2	0	0
0	1	3	0	1	3
2	0	0	2	0	0

-1	3	9
0	0	0
-9	-3	1

$BC_{11} = (-1\times0 + 3\times1 + 9\times3) + (0\times2 + 0\times0 + 0\times0) + (-9\times0 + (-3)\times1 + 1\times3) = 30$

$B_{12} = (-1\times1 + 3\times3 + 9\times0) + (0\times0 + 0\times0 + 0\times2) + (-9\times1 + (-3)\times3 + 1\times0) = -10$

$BC_{43} = (-1\times3 + 3\times0 + 9\times1) + (0\times0 + 0\times2 + 0\times9) + (-9\times3 + (-3)\times0 + 1\times9) = -20$

$BC_{14} = (-1\times0 + 3\times1 + 9\times3) + (0\times2 + 0\times0 + 0\times9) + (-9\times0 + (-3)\times1 + 1\times3) = 30$

$BC_{21} = (-1\times2 + 3\times0 + 9\times0) + (0\times0 + 0\times1 + 0\times3) + (-9\times2 + (-3)\times0 + 1\times0) = -20$

$BC_{22} = (-1\times0 + 3\times0 + 9\times2) + (0\times1 + 0\times3 + 0\times0) + (-9\times0 + (-3)\times0 + 1\times2) = 20$

$BC_{23} = (-1\times0 + 3\times2 + 9\times9) + (0\times3 + 0\times0 + 0\times1) + (-9\times0 + (-3)\times2 + 1\times9) = 0$

$BC_{24} = (-1\times2 + 3\times0 + 9\times0) + (0\times0 + 0\times1 + 0\times3) + (-9\times2 + (-3)\times0 + 1\times9) = -20$

$BC_{31} = (-1\times0 + 3\times1 + 9\times3) + (0\times2 + 0\times0 + 0\times9) + (-9\times0 + (-3)\times1 + 1\times3) = 30$

$BC_{32} = (-1\times1 + 3\times3 + 9\times0) + (0\times0 + 0\times0 + 0\times3) + (-9\times3 + (-3)\times0 + 1\times1) = -18$

$BC_{33} = (-1\times3 + 3\times0 + 9\times1) + (0\times0 + 0\times2 + 0\times9) + (-9\times3 + (-3)\times0 + 1\times1) = -20$

$BC_{34} = (-1\times0 + 3\times1 + 9\times3) + (0\times2 + 0\times0 + 0\times0) + (-9\times0 + (-3)\times1 + 1\times3) = 30$

$BC_{41} = (-1\times2 + 3\times0 + 9\times0) + (0\times0 + 0\times1 + 0\times3) + (-9\times2 + (-3)\times0 + 1\times0) = -20$

$BC_{42} = (-1\times0 + 3\times0 + 9\times2) + (0\times1 + 0\times3 + 0\times0) + (-9\times0 + (-3)\times0 + 1\times2) = 20$

$BC_{43} = (-1\times0 + 3\times2 + 9\times0) + (0\times3 + 0\times0 + 0\times1) + (-9\times0 + (-3)\times2 + 1\times0) = 0$

$BC_{44} = (-1\times2 + 3\times0 + 9\times0) + (0\times0 + 0\times1 + 0\times3) + (-9\times2 + (-3)\times0 + 1\times0) = -20$

$B\ conv\ C =$

30	-10	-20	30
-20	20	0	-20
30	-18	-20	30
-20	20	0	-20

$F_1 = RA + GB + BC$

26	15	24	34
26	17	25	29
30	25	20	36
32	30	23	31

RA

+

77	64	36	37
71	66	20	15
86	56	42	26
69	57	34	15

GB

+

30	-10	-20	30
-20	20	0	-20
30	-18	-20	30
-20	20	0	-20

F1

133	69	40	101
77	103	45	24
146	63	42	92
80	107	57	26

Applying F_2 to the image

taking transpose of A, B and C

A^t

2	1	0
4	9	1
9	1	3

B^t

3	1	9
1	9	4
0	1	2

C^t =

-1	0	-9
3	0	-3
9	0	1

Now applying the filters to image

1	0	1	0	2	0
2	1	1	0	2	1
1	0	1	0	1	2
2	1	2	0	1	0
1	0	2	0	2	1
2	1	2	0	2	2

R

conv

2	1	0
4	9	1
9	1	3

$RA_{11} = (2\times1 + 1\times0 + 0\times1) + (4\times2 + 9\times1 + 1\times1) + (9\times1 + 1\times0 + 3\times1) = 32$

$RA_{12} = (2\times0 + 1\times1 + 0\times0) + (4\times1 + 9\times1 + 1\times0) + (9\times0 + 1\times1 + 3\times0) = 15$

$RA_{13} = (2\times1 + 1\times0 + 0\times2) + (4\times1 + 9\times0 + 1\times2) + (9\times1 + 1\times0 + 3\times1) = 20$

$R_{A14} = (2\times0 + 1\times2 + 0\times0) + (4\times0 + 9\times2 + 1\times1) + (9\times0 + 1\times1 + 3\times2) = 28$

$R_{A21} = (2\times2 + 1\times1 + 0\times1) + (4\times1 + 9\times0 + 1\times1) + (9\times2 + 1\times1 + 3\times2) = 35$

$R_{A22} = (2\times1 + 1\times1 + 0\times0) + (4\times0 + 9\times1 + 1\times0) + (9\times1 + 1\times2 + 3\times0) = 23$

$R_{A23} = (2\times1 + 1\times0 + 0\times2) + (4\times1 + 9\times0 + 1\times1) + (9\times2 + 1\times0 + 3\times1) = 27$

$R_{A24} = (2\times0 + 1\times2 + 0\times1) + (4\times0 + 9\times1 + 1\times2) + (9\times0 + 1\times1 + 3\times0) = 14$

$R_{A31} = (2\times1 + 1\times0 + 0\times1) + (4\times2 + 9\times1 + 1\times2) + (9\times1 + 1\times0 + 3\times2) = 36$

$R_{A32} = (2\times0 + 1\times1 + 0\times0) + (4\times1 + 9\times2 + 1\times0) + (9\times0 + 1\times2 + 3\times0) = 25$

$R_{A33} = (2\times1 + 1\times0 + 0\times1) + (4\times2 + 9\times0 + 1\times1) + (9\times2 + 1\times0 + 3\times1) = 35$

$R_{A34} = (2\times0 + 1\times1 + 0\times2) + (4\times0 + 9\times1 + 1\times0) + (9\times0 + 1\times2 + 3\times1) = 15$

$RA_{11} = (2\times2 + 1\times1 + 0\times2) + (4\times1 + 9\times0 + 1\times2) + (9\times2 + 1\times1 + 3\times3) = 36$

$RA_{12} = (2\times1 + 1\times2 + 0\times0) + (4\times0 + 9\times2 + 1\times0) + (9\times1 + 1\times2 + 3\times0) = 33$

$RA_{13} = (2\times2 + 1\times0 + 0\times1) + (4\times2 + 9\times0 + 1\times2) + (9\times2 + 1\times0 + 3\times2) = 38$

$RA_{14} = (2\times0 + 1\times1 + 0\times0) + (4\times0 + 9\times2 + 1\times1) + (9\times0 + 1\times2 + 3\times2) = 28$

R Conv A^T =

32	15	20	28
35	23	27	14
36	25	35	15
36	33	38	28

G Conv B^T

3	1	0	1	0	2
2	2	2	0	2	1
3	3	3	1	0	3
2	3	0	0	1	3
3	3	3	1	0	1
2	1	2	0	2	2

G

3	1	9
1	9	4
0	1	2

B^T

$GB_{11} = (3\times3 + 1\times1 + 9\times0) + (1\times2 + 9\times2 + 4\times2) + (0\times3 + 1\times3 + 2\times3) = 47$

$GB_{12} = (3\times1 + 1\times0 + 9\times1) + (1\times2 + 9\times2 + 4\times0) + (0\times3 + 1\times3 + 2\times1) = 37$

$G_{B13} = (3\times0 + 1\times1 + 9\times0) + (1\times2 + 9\times0 + 4\times2) + (0\times3 + 1\times1 + 2\times0) = 12$

$G_{B14} = (3\times1 + 1\times0 + 9\times2) + (1\times0 + 9\times2 + 4\times1) + (0\times1 + 1\times0 + 2\times3) = 49$

$G_{B21} = (3\times2 + 1\times2 + 9\times2) + (1\times3 + 9\times3 + 4\times3) + (0\times2 + 1\times3 + 2\times0) = 71$

$G_{B22} = (3\times2 + 1\times2 + 9\times0) + (1\times3 + 9\times3 + 4\times1) + (0\times3 + 1\times0 + 2\times0) = 42$

$G_{B23} = (3\times2 + 1\times0 + 9\times2) + (1\times3 + 9\times1 + 4\times0) + (0\times0 + 1\times0 + 2\times1) = 38$

$G_{B24} = (3\times0 + 1\times2 + 9\times1) + (1\times1 + 9\times0 + 4\times3) + (0\times0 + 1\times1 + 2\times3) = 31$

$G_{B31} = (3\times3 + 1\times3 + 9\times3) + (1\times2 + 9\times3 + 4\times0) + (0\times3 + 1\times3 + 2\times3) = 77$

$G_{B32} = (3\times3 + 1\times3 + 9\times1) + (1\times3 + 9\times0 + 4\times0) + (0\times3 + 1\times3 + 2\times1) = 29$

$G_{B33} = (3\times3 + 1\times1 + 9\times0) + (1\times0 + 9\times0 + 4\times1) + (0\times3 + 1\times1 + 2\times0) = 15$

$G_{B34} = (3\times1 + 1\times0 + 9\times3) + (1\times0 + 9\times1 + 4\times3) + (0\times1 + 1\times0 + 2\times1) = 53$

$C_1B_{41} = (3\times2 + 1\times3 + 9\times0) + (1\times3 + 9\times3 + 4\times3) + (0\times2 + 1\times1 + 2\times2) = 56$

$C_1B_{42} = (3\times3 + 1\times0 + 9\times0) + (1\times3 + 9\times3 + 4\times3) + (0\times1 + 1\times2 + 2\times0) = 45$

$C_1B_{43} = (3\times0 + 1\times0 + 9\times1) + (1\times3 + 9\times1 + 4\times3) + (0\times2 + 1\times0 + 2\times2) = 25$

$C_1B_{44} = (3\times0 + 1\times1 + 9\times3) + (1\times1 + 9\times0 + 4\times3) + (0\times0 + 1\times2 + 2\times2) = 39$

47	37	12	49
71	42	38	31
77	29	15	53
56	45	25	39

Now B conv C^T

0	1	3	0	1	3
2	0	0	2	0	0
0	1	3	0	1	3
2	0	0	2	0	0
0	1	3	0	1	3
2	0	0	2	0	0

$C^+ =$

-1	0	-9
3	0	-3
9	0	1

$Bc_{11} = (-1\times0 + 0\times1 + (-9)\times3) + (3\times2 + 0\times0 + (-3)\times0) + (9\times0 + 0\times1 + 1\times3) = -18$

$Bc_{12} = (-1\times1 + 0\times3 + (-9)\times0) + (3\times0 + 0\times0 + (-3)\times2) + (9\times1 + 0\times3 + 1\times0) = 2$

$Bc_{13} = (-1\times3 + 0\times0 + (-9)\times1) + (3\times0 + 0\times2 + (-3)\times0) + (9\times3 + 0\times0 + 1\times1) = 16$

$BC_{14} = (-1\times0 + 0\times1 + (-9)\times3) + (3\times2+0\times0+(-3)\times0) + (9\times0+0\times1+1\times3) = -18$

$BC_{21} = (-1\times2 + 0\times0+(-9)\times0) + (3\times0+0\times1+(-3)\times3) + (9\times2+0\times0+1\times0) = 7$

$BC_{22} = (-1\times0+0\times0+(-9)\times2) + (3\times1+0\times3+(-3)\times0) + (9\times0+0\times0+1\times2) = -13$

$BC_{23} = (-1\times0+0\times2+(-9)\times0) + (3\times3+0\times0+(-3)\times0) + (9\times0+0\times2+1\times0) = 6$

$BC_{24} = (-1\times2+0\times0+(-9)\times0) + (3\times0+0\times1+(-3)\times3) + (9\times2+0\times0+1\times0) = 7$

$BC_{31} = (-1\times0+0\times1+(-9)\times3) + (3\times2+0\times0+(-3)\times0) + (9\times0+0\times1+1\times3) = -18$

$BC_{32} = (-1\times1+0\times3+(-9)\times0) + (3\times0+0\times0+(-3)\times2) + (9\times1+0\times3+1\times0) = 2$

$BC_{33} = (-1\times3+0\times0+(-9)\times1) + (3\times0+0\times2+(-3)\times0) + (9\times3+0\times0+1\times0) = 16$

$BC_{34} = (-1\times0+0\times1+(-9)\times3) + (3\times2+0\times0+(-3)\times0) + (9\times0+0\times1+1\times3) = -18$

$BC_{41} = (-1\times2+0\times0+(-9)\times0) + (3\times0+0\times1+(-3)\times3) + (9\times2+0\times0+1\times0) = 7$

$BC_{42} = (-1\times0+0\times0+(-9)\times2) + (3\times0+0\times1+(-3)\times3) + (9\times0+0\times0+1\times2) = -13$

$BC_{43} = (-1\times0 + 0\times2 + (-9)\times0) + (3\times3 + 0\times0 + (-3)\times1) + (9\times0 + 0\times2 + 1\times0) = 6$

$BC_{44} = (-1\times2 + 0\times0 + (-9)\times0) + (3\times0 + 0\times1 + (-3)\times3) + (9\times2 + 0\times0 + 1\times0) = 7$

BC^T

-18	2	16	-18
7	-13	6	7
-18	2	16	-18
7	-13	6	7

$F_2 = RA + GB + BC$

RA

32	15	20	28
35	23	27	14
36	25	35	15
36	33	38	28

+ GB

47	37	12	49
71	42	38	31
77	29	15	53
56	45	25	39

+ BC

-18	2	16	-18
7	-13	6	7
-18	2	16	-18
7	-13	6	7

=

66	54	48	59
113	52	71	52
95	56	66	50
99	65	69	74

F_2

Now adding bias to the F_1 and F_2

$F_1 + 2 =$

135	71	42	103
79	105	47	26
148	65	44	94
82	109	59	28

$F_2 + 1 =$

67	55	49	60
114	53	72	53
96	57	67	51
100	66	70	75

Apply ReLU activation Function on the output volume

Answer:- There will be no effect of applying Relu function on the output because our output have all positive value it will remain same.

ReLU $F_1 + 2 =$

135	71	42	103
79	105	47	26
148	65	44	94
82	109	59	28

ReLU $F_2 + 1$

67	55	49	60
114	53	72	53
96	57	67	51
100	66	70	75

Apply Max Polling with F=2 and S=2

Maxpooling (ReLU F1+2) =

135	103
148	94

Maxpooling (ReLU F2+1) =

114	72
100	75

Problem no 2

Layer	Hyper-Parameters	Activation Shape	Number of Para
Input	-	128x128x3	0
conv-1	f=3, S=1, P=1; 16fil	128x128x16	((3x3x3)+1)x16=448
Pool-1	f=2, S=2;	64x64x16	0
conv-2	f=5, S=1, P=2; 32fil	64x64x32	((5x5x16)+1)x32=12832
Pool-2	f=2, S=2;	32x32x32	0
conv-3	f=3, S=1, P=1; 64fil	32x32x64	(3x3x32)+1)x64=18496
Pool-3	f=2, S=2;	16x16x64	0
FC-4	256 neuron	256x1	16x16x64x256+256=4194560
FC-5	128 neuron	128x1	256x128+128=32896
Softmax	64 neuron	64x1	128x64+64=8256