CS344 - Operating Systems Laboratory

ML2 - edge detection computation

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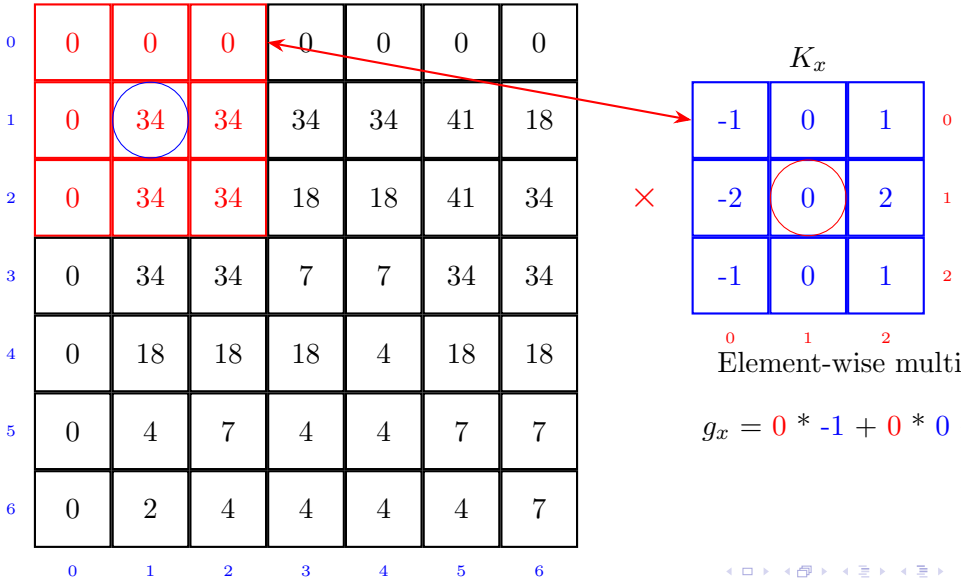
Edge detection computation at matrix element (1, 1)

	0	1	2	3	4	5	6
0	0	0	0	0	0	0	0
1	0	34	34	34	34	41	18
2	0	34	34	18	18	41	34
3	0	34	34	7	7	34	34
4	0	18	18	18	4	18	18
5	0	4	7	4	4	7	7
6	0	2	4	4	4	4	7

Edge detection computation at matrix element (1, 1)



Edge detection computation at matrix element (1, 1)

	0	1	2	3	4	5	6
0	0	0	0	0	0	0	0
1	0	34	34	34	34	41	18
2	0	34	34	18	18	41	34
3	0	34	34	7	7	34	34
4	0	18	18	18	4	18	18
5	0	4	7	4	4	7	7
6	0	2	4	4	4	4	7

K_x

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

0 * -2 + 34 * 0 + 34 * 2 +

Edge detection computation at matrix element (1, 1)

	0	1	2	3	4	5	6
0	0	0	0	0	0	0	0
1	0	34	34	34	34	41	18
2	0	34	34	18	18	41	34
3	0	34	34	7	7	34	34
4	0	18	18	18	4	18	18
5	0	4	7	4	4	7	7
6	0	2	4	4	4	4	7

$\times$

K_x

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

0 1 2

$0 * -1 + 34 * 0 + 34 * 1 = 102$

Edge detection computation at matrix element (1, 1)

0	0	0	0	0	0	0	0
1	0	34	34	34	34	41	18
2	0	34	34	18	18	41	34
3	0	34	34	7	7	34	34
4	0	18	18	18	4	18	18
5	0	4	7	4	4	7	7
6	0	2	4	4	4	4	7
	0	1	2	3	4	5	6

$\times$

K_x

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

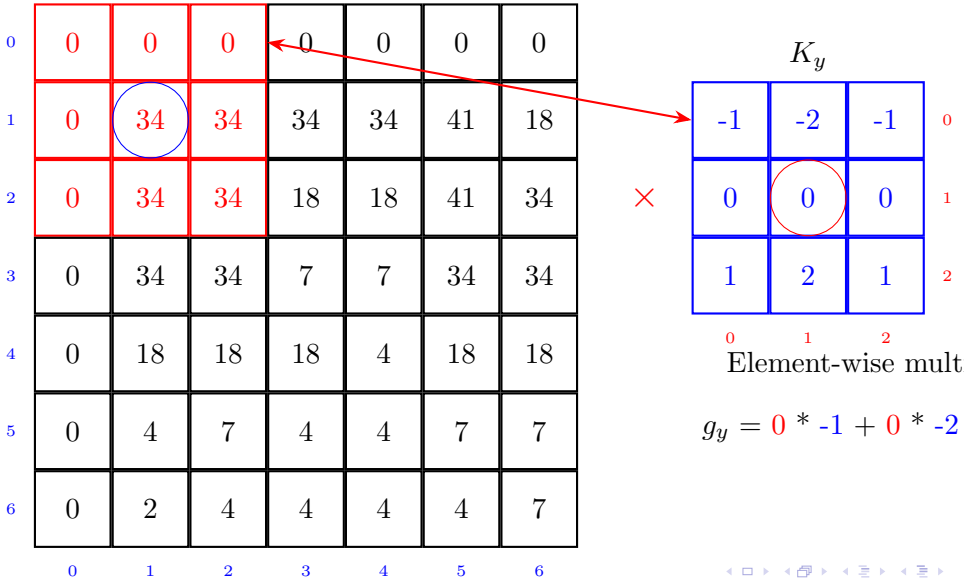
Element-wise multiplication

$g_x = 0 * -1 + 0 * 0 + 0 * 1 +$

$0 * -2 + 34 * 0 + 34 * 2 +$

$0 * -1 + 34 * 0 + 34 * 1 = 102$

Edge detection computation at matrix element (1, 1)



Edge detection computation at matrix element (1, 1)

	0	1	2	3	4	5	6
0	0	0	0	0	0	0	0
1	0	34	34	34	34	41	18
2	0	34	34	18	18	41	34
3	0	34	34	7	7	34	34
4	0	18	18	18	4	18	18
5	0	4	7	4	4	7	7
6	0	2	4	4	4	4	7

K_y

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

$0 * 0 + 34 * 0 + 34 * 0 +$

Edge detection computation at matrix element (1, 1)

	0	1	2	3	4	5	6
0	0	0	0	0	0	0	0
1	0	34	34	34	34	41	18
2	0	34	34	18	18	41	34
3	0	34	34	7	7	34	34
4	0	18	18	18	4	18	18
5	0	4	7	4	4	7	7
6	0	2	4	4	4	4	7

$\times$

K_y

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

$0 * 1 + 34 * 2 + 34 * 1 = 102$

Edge detection computation at matrix element (1, 1)

0	0	0	0	0	0	0	0
1	0	34	34	34	34	41	18
2	0	34	34	18	18	41	34
3	0	34	34	7	7	34	34
4	0	18	18	18	4	18	18
5	0	4	7	4	4	7	7
6	0	2	4	4	4	4	7
	0	1	2	3	4	5	6

×

K_y

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

Element-wise multiplication

$g_y = 0 * -1 + 0 * -2 + 0 * -1 +$

$0 * 0 + 34 * 0 + 34 * 0 +$

$0 * 1 + 34 * 2 + 34 * 1 = 102$

Edge detection computation at matrix element (1, 1)

	0	1	2	3	4	5	6
0	0	0	0	0	0	0	0
1	0	34	34	34	34	41	18
2	0	34	34	18	18	41	34
3	0	34	34	7	7	34	34
4	0	18	18	18	4	18	18
5	0	4	7	4	4	7	7
6	0	2	4	4	4	4	7

$$G = \sqrt{g_x^2 + g_y^2}$$
$$= \sqrt{102^2 + 102^2}$$
$$= 144.25$$

if $G \geq 255$ then $G = 255$

Edge detection computation at matrix element (1, 2)

	0	1	2	3	4	5	6
0	0	0	0	0	0	0	0
1	0	34	34	34	34	41	18
2	0	34	34	18	18	41	34
3	0	34	34	7	7	34	34
4	0	18	18	18	4	18	18
5	0	4	7	4	4	7	7
6	0	2	4	4	4	4	7

Edge detection computation at matrix element (1, 2)

	0	1	2	3	4	5	6
0	0	0	0	0	0	0	0
1	0	34	34	34	34	41	18
2	0	34	34	18	18	41	34
3	0	34	34	7	7	34	34
4	0	18	18	18	4	18	18
5	0	4	7	4	4	7	7
6	0	2	4	4	4	4	7

$\times$

K_x

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

Element-wise multiplication

$g_x = 0 * -1 + 0 * 0 + 0 * 1 +$

Edge detection computation at matrix element (1, 2)

	0	1	2	3	4	5	6
0	0	0	0	0	0	0	0
1	0	34	34	34	34	41	18
2	0	34	34	18	18	41	34
3	0	34	34	7	7	34	34
4	0	18	18	18	4	18	18
5	0	4	7	4	4	7	7
6	0	2	4	4	4	4	7

$\times$

K_x

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

0 1 2

$34 * -2 + 34 * 0 + 34 * 2 +$

Edge detection computation at matrix element (1, 2)

	0	1	2	3	4	5	6
0	0	0	0	0	0	0	0
1	0	34	34	34	34	41	18
2	0	34	34	18	18	41	34
3	0	34	34	7	7	34	34
4	0	18	18	18	4	18	18
5	0	4	7	4	4	7	7
6	0	2	4	4	4	4	7

$\times$

K_x

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

34 * -1 + 34 * 0 + 18 * 1 = -16

Edge detection computation at matrix element (1, 2)

0	0	0	0	0	0	0	0
1	0	34	34	34	34	41	18
2	0	34	34	18	18	41	34
3	0	34	34	7	7	34	34
4	0	18	18	18	4	18	18
5	0	4	7	4	4	7	7
6	0	2	4	4	4	4	7
	0	1	2	3	4	5	6

×

K_x

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

0 1 2 (row indices) | 0 1 2 (column indices)

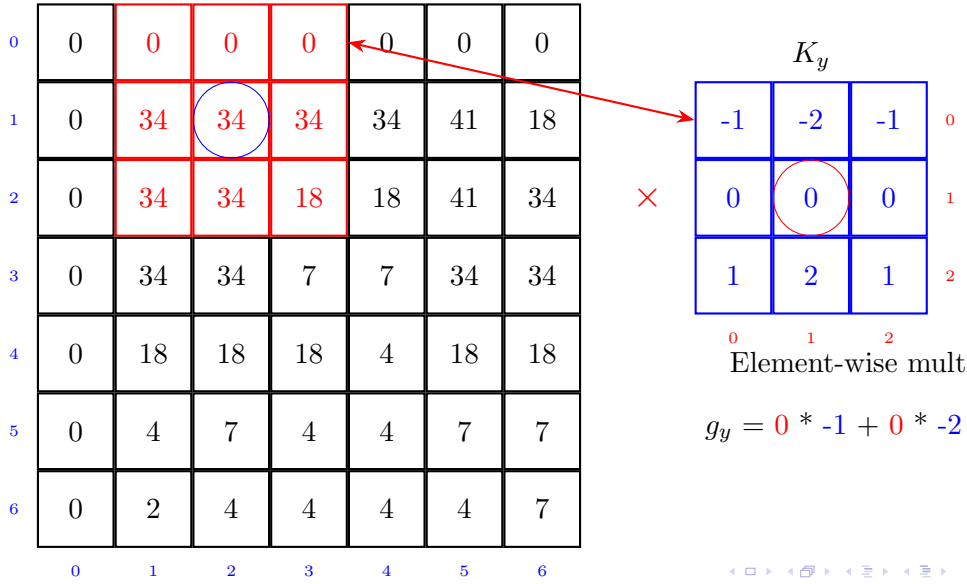
Element-wise multiplication

g_x = 0 * -1 + 0 * 0 + 0 * 1 +

34 * -2 + 34 * 0 + 34 * 2 +

34 * -1 + 34 * 0 + 18 * 1 = -16

Edge detection computation at matrix element (1, 2)



Edge detection computation at matrix element (1, 2)

	0	1	2	3	4	5	6
0	0	0	0	0	0	0	0
1	0	34	34	34	34	41	18
2	0	34	34	18	18	41	34
3	0	34	34	7	7	34	34
4	0	18	18	18	4	18	18
5	0	4	7	4	4	7	7
6	0	2	4	4	4	4	7

K_y

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

$$34 * 0 + 34 * 0 + 34 * 0 +$$

Edge detection computation at matrix element (1, 2)

	0	1	2	3	4	5	6
0	0	0	0	0	0	0	0
1	0	34	34	34	34	41	18
2	0	34	34	18	18	41	34
3	0	34	34	7	7	34	34
4	0	18	18	18	4	18	18
5	0	4	7	4	4	7	7
6	0	2	4	4	4	4	7

$\times$

K_y

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

$34 * 1 + 34 * 2 + 18 * 1 = 120$

Edge detection computation at matrix element (1, 2)

	0	1	2	3	4	5	6
0	0	0	0	0	0	0	0
1	0	34	34	34	34	41	18
2	0	34	34	18	18	41	34
3	0	34	34	7	7	34	34
4	0	18	18	18	4	18	18
5	0	4	7	4	4	7	7
6	0	2	4	4	4	4	7

×

K_y

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

Element-wise multiplication

g_y = 0 * -1 + 0 * -2 + 0 * -1 +

34 * 0 + 34 * 0 + 34 * 0 +

34 * 1 + 34 * 2 + 18 * 1 = 120

Edge detection computation at matrix element (1, 2)

	0	1	2	3	4	5	6
0	0	0	0	0	0	0	0
1	0	34	34	34	34	41	18
2	0	34	34	18	18	41	34
3	0	34	34	7	7	34	34
4	0	18	18	18	4	18	18
5	0	4	7	4	4	7	7
6	0	2	4	4	4	4	7

$$G = \sqrt{g_x^2 + g_y^2}$$
$$= \sqrt{(-16)^2 + 120^2}$$
$$= 121.06$$

if $G \geq 255$ then $G = 255$

Edge detection computation at matrix element (1, 3)

	0	1	2	3	4	5	6
0	0	0	0	0	0	0	0
1	0	34	34	34	34	41	18
2	0	34	34	18	18	41	34
3	0	34	34	7	7	34	34
4	0	18	18	18	4	18	18
5	0	4	7	4	4	7	7
6	0	2	4	4	4	4	7

Edge detection computation at matrix element (1, 3)

	0	1	2	3	4	5	6
0	0	0	0	0	0	0	0
1	0	34	34	34	34	41	18
2	0	34	34	18	18	41	34
3	0	34	34	7	7	34	34
4	0	18	18	18	4	18	18
5	0	4	7	4	4	7	7
6	0	2	4	4	4	4	7

$\times$

K_x

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

Element-wise multiplication

$g_x = 0 * -1 + 0 * 0 + 0 * 1 +$

Edge detection computation at matrix element (1, 3)

	0	1	2	3	4	5	6
0	0	0	0	0	0	0	0
1	0	34	34	34	34	41	18
2	0	34	34	18	18	41	34
3	0	34	34	7	7	34	34
4	0	18	18	18	4	18	18
5	0	4	7	4	4	7	7
6	0	2	4	4	4	4	7

$\times$

K_x

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

$34 * -2 + 34 * 0 + 34 * 2 +$

Edge detection computation at matrix element (1, 3)

	0	1	2	3	4	5	6
0	0	0	0	0	0	0	0
1	0	34	34	34	34	41	18
2	0	34	34	18	18	41	34
3	0	34	34	7	7	34	34
4	0	18	18	18	4	18	18
5	0	4	7	4	4	7	7
6	0	2	4	4	4	4	7

$\times$

K_x

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

34 * -1 + 18 * 0 + 18 * 1 = -16

Edge detection computation at matrix element (1, 3)

0	0	0	0	0	0	0	0
1	0	34	34	34	34	41	18
2	0	34	34	18	18	41	34
3	0	34	34	7	7	34	34
4	0	18	18	18	4	18	18
5	0	4	7	4	4	7	7
6	0	2	4	4	4	4	7
	0	1	2	3	4	5	6

×

K_x

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

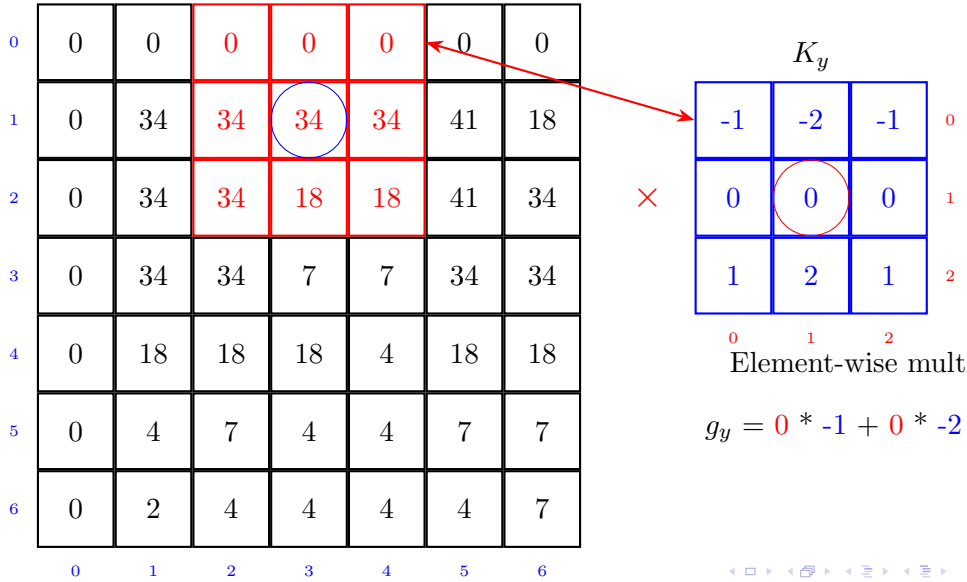
Element-wise multiplication

$g_x = 0 * -1 + 0 * 0 + 0 * 1 +$

$34 * -2 + 34 * 0 + 34 * 2 +$

$34 * -1 + 18 * 0 + 18 * 1 = -16$

Edge detection computation at matrix element (1, 3)



Edge detection computation at matrix element (1, 3)

0	0	0	0	0	0	0	0
1	0	34	34	34	34	41	18
2	0	34	34	18	18	41	34
3	0	34	34	7	7	34	34
4	0	18	18	18	4	18	18
5	0	4	7	4	4	7	7
6	0	2	4	4	4	4	7
	0	1	2	3	4	5	6

$\times$

K_y

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

$34 * 0 + 34 * 0 + 34 * 0 +$

Edge detection computation at matrix element (1, 3)

	0	1	2	3	4	5	6
0	0	0	0	0	0	0	0
1	0	34	34	34	34	41	18
2	0	34	34	18	18	41	34
3	0	34	34	7	7	34	34
4	0	18	18	18	4	18	18
5	0	4	7	4	4	7	7
6	0	2	4	4	4	4	7

$\times$

K_y

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

$34 * 1 + 18 * 2 + 18 * 1 = 88$

Edge detection computation at matrix element (1, 3)

0	0	0	0	0	0	0	0
1	0	34	34	34	34	41	18
2	0	34	34	18	18	41	34
3	0	34	34	7	7	34	34
4	0	18	18	18	4	18	18
5	0	4	7	4	4	7	7
6	0	2	4	4	4	4	7
	0	1	2	3	4	5	6

$\times$

K_y

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

Element-wise multiplication

g_y = 0 * -1 + 0 * -2 + 0 * -1 +

34 * 0 + 34 * 0 + 34 * 0 +

34 * 1 + 18 * 2 + 18 * 1 = 88

Edge detection computation at matrix element (1, 3)

	0	1	2	3	4	5	6
0	0	0	0	0	0	0	0
1	0	34	34	34	34	41	18
2	0	34	34	18	18	41	34
3	0	34	34	7	7	34	34
4	0	18	18	18	4	18	18
5	0	4	7	4	4	7	7
6	0	2	4	4	4	4	7

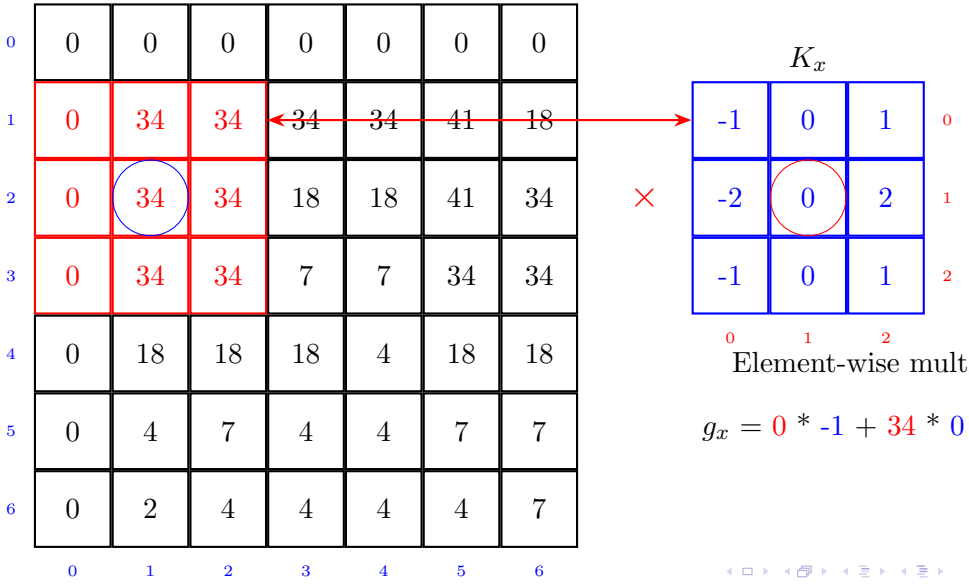
$$G = \sqrt{g_x^2 + g_y^2}$$
$$= \sqrt{(-16)^2 + 88^2}$$
$$= 89.44$$

if $G \geq 255$ then $G = 255$

Edge detection computation at matrix element (2, 1)

	0	1	2	3	4	5	6
0	0	0	0	0	0	0	0
1	0	34	34	34	34	41	18
2	0	34	34	18	18	41	34
3	0	34	34	7	7	34	34
4	0	18	18	18	4	18	18
5	0	4	7	4	4	7	7
6	0	2	4	4	4	4	7

Edge detection computation at matrix element (2, 1)



Edge detection computation at matrix element (2, 1)

	0	1	2	3	4	5	6
0	0	0	0	0	0	0	0
1	0	34	34	34	34	41	18
2	0	34	34	18	18	41	34
3	0	34	34	7	7	34	34
4	0	18	18	18	4	18	18
5	0	4	7	4	4	7	7
6	0	2	4	4	4	4	7

K_x

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

0 1 2

0 * -2 + 34 * 0 + 34 * 2 +

Edge detection computation at matrix element (2, 1)

	0	1	2	3	4	5	6
0	0	0	0	0	0	0	0
1	0	34	34	34	34	41	18
2	0	34	34	18	18	41	34
3	0	34	34	7	7	34	34
4	0	18	18	18	4	18	18
5	0	4	7	4	4	7	7
6	0	2	4	4	4	4	7

$\times$

K_x

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

$0 * -1 + 34 * 0 + 34 * 1 = 136$

Edge detection computation at matrix element (2, 1)

	0	1	2	3	4	5	6
0	0	0	0	0	0	0	0
1	0	34	34	34	34	41	18
2	0	34	34	18	18	41	34
3	0	34	34	7	7	34	34
4	0	18	18	18	4	18	18
5	0	4	7	4	4	7	7
6	0	2	4	4	4	4	7

$\times$

K_x

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

0 1 2

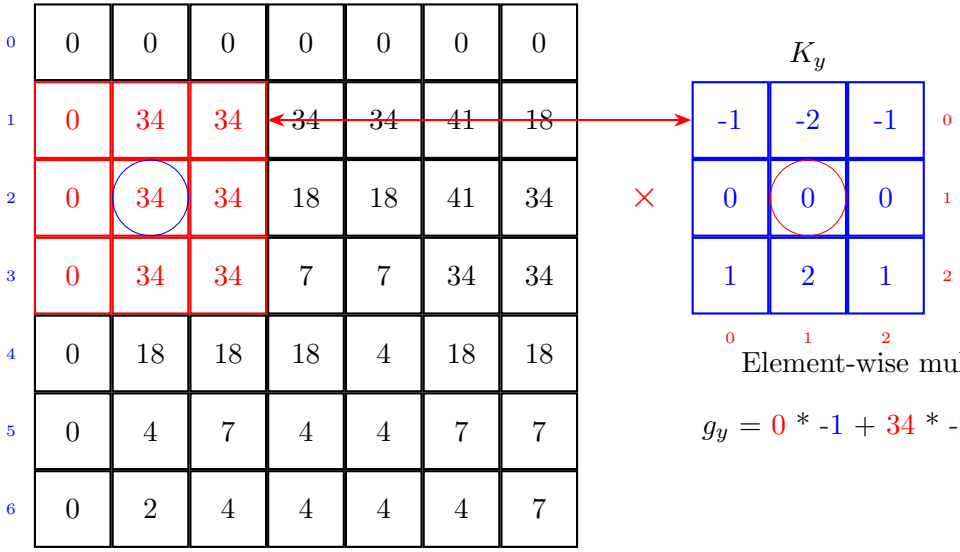
Element-wise multiplication

$g_x = 0 * -1 + 34 * 0 + 34 * 1 +$

$0 * -2 + 34 * 0 + 34 * 2 +$

$0 * -1 + 34 * 0 + 34 * 1 = 136$

Edge detection computation at matrix element (2, 1)



Edge detection computation at matrix element (2, 1)

	0	1	2	3	4	5	6
0	0	0	0	0	0	0	0
1	0	34	34	34	34	41	18
2	0	34	34	18	18	41	34
3	0	34	34	7	7	34	34
4	0	18	18	18	4	18	18
5	0	4	7	4	4	7	7
6	0	2	4	4	4	4	7

K_y

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

$0 * 0 + 34 * 0 + 34 * 0 +$

Edge detection computation at matrix element (2, 1)

	0	1	2	3	4	5	6
0	0	0	0	0	0	0	0
1	0	34	34	34	34	41	18
2	0	34	34	18	18	41	34
3	0	34	34	7	7	34	34
4	0	18	18	18	4	18	18
5	0	4	7	4	4	7	7
6	0	2	4	4	4	4	7

$\times$

K_y

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

$0 * 1 + 34 * 2 + 34 * 1 = 0$

Edge detection computation at matrix element (2, 1)

	0	1	2	3	4	5	6
0	0	0	0	0	0	0	0
1	0	34	34	34	34	41	18
2	0	34	34	18	18	41	34
3	0	34	34	7	7	34	34
4	0	18	18	18	4	18	18
5	0	4	7	4	4	7	7
6	0	2	4	4	4	4	7

$\times$

K_y

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

Element-wise multiplication

$g_y = 0 * -1 + 34 * -2 + 34 * -1 +$

$0 * 0 + 34 * 0 + 34 * 0 +$

$0 * 1 + 34 * 2 + 34 * 1 = 0$

Edge detection computation at matrix element (2, 1)

	0	1	2	3	4	5	6
0	0	0	0	0	0	0	0
1	0	34	34	34	34	41	18
2	0	34	34	18	18	41	34
3	0	34	34	7	7	34	34
4	0	18	18	18	4	18	18
5	0	4	7	4	4	7	7
6	0	2	4	4	4	4	7

$$G = \sqrt{g_x^2 + g_y^2}$$
$$= \sqrt{(136)^2 + 0^2}$$
$$= 136$$

if $G \geq 255$ then $G = 255$

Edge detection computation at matrix element (2, 2)

	0	1	2	3	4	5	6
0	0	0	0	0	0	0	0
1	0	34	34	34	34	41	18
2	0	34	34	18	18	41	34
3	0	34	34	7	7	34	34
4	0	18	18	18	4	18	18
5	0	4	7	4	4	7	7
6	0	2	4	4	4	4	7

Edge detection computation at matrix element (2, 2)

	0	1	2	3	4	5	6
0	0	0	0	0	0	0	0
1	0	34	34	34	34	41	18
2	0	34	34	18	18	41	34
3	0	34	34	7	7	34	34
4	0	18	18	18	4	18	18
5	0	4	7	4	4	7	7
6	0	2	4	4	4	4	7

$\times$

K_x

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

Element-wise multiplication

$g_x = 34 * -1 + 34 * 0 + 34 * 1 +$

Edge detection computation at matrix element (2, 2)

	0	1	2	3	4	5	6
0	0	0	0	0	0	0	0
1	0	34	34	34	34	41	18
2	0	34	34	18	18	41	34
3	0	34	34	7	7	34	34
4	0	18	18	18	4	18	18
5	0	4	7	4	4	7	7
6	0	2	4	4	4	4	7

K_x

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

34 * -2 + 34 * 0 + 18 * 2 +

Edge detection computation at matrix element (2, 2)

	0	1	2	3	4	5	6
0	0	0	0	0	0	0	0
1	0	34	34	34	34	41	18
2	0	34	34	18	18	41	34
3	0	34	34	7	7	34	34
4	0	18	18	18	4	18	18
5	0	4	7	4	4	7	7
6	0	2	4	4	4	4	7

$\times$

K_x

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

34 * -1 + 34 * 0 + 7 * 1 = -59

Edge detection computation at matrix element (2, 2)

	0	1	2	3	4	5	6
0	0	0	0	0	0	0	0
1	0	34	34	34	34	41	18
2	0	34	34	18	18	41	34
3	0	34	34	7	7	34	34
4	0	18	18	18	4	18	18
5	0	4	7	4	4	7	7
6	0	2	4	4	4	4	7

$\times$

K_x

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

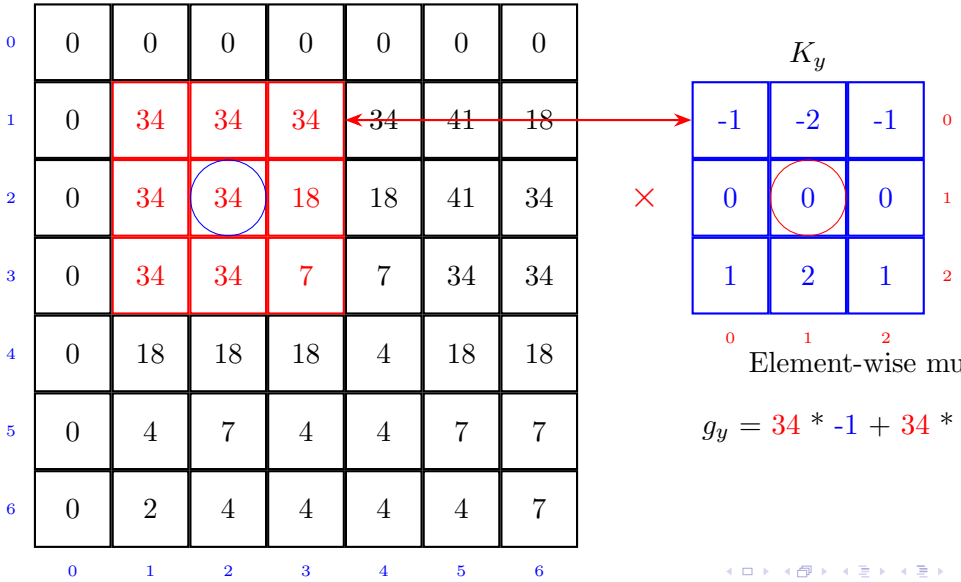
Element-wise multiplication

g_x = 34 * -1 + 34 * 0 + 34 * 1 +

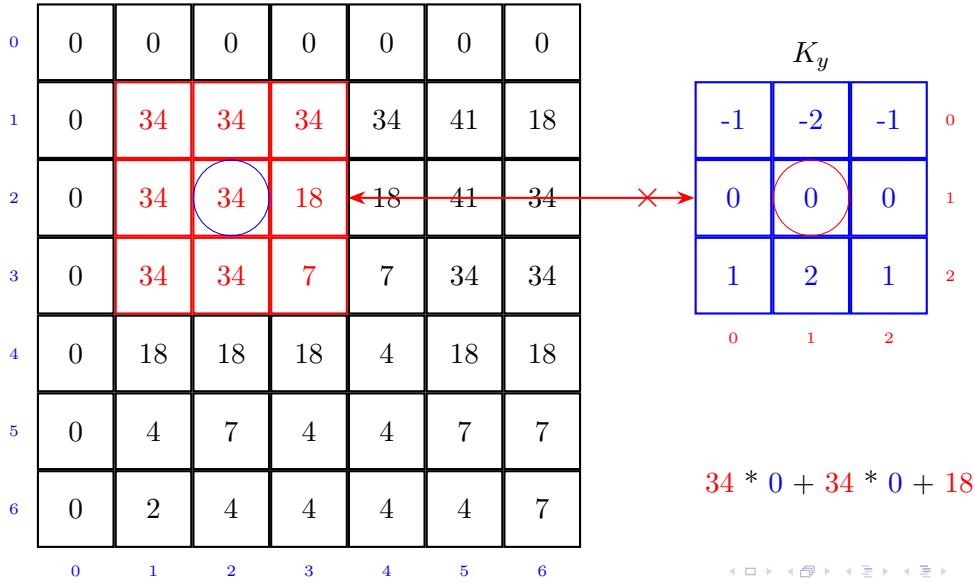
34 * -2 + 34 * 0 + 18 * 2 +

34 * -1 + 34 * 0 + 7 * 1 = -59

Edge detection computation at matrix element (2, 2)



Edge detection computation at matrix element (2, 2)



Edge detection computation at matrix element (2, 2)

0	0	0	0	0	0	0	0
1	0	34	34	34	34	41	18
2	0	34	34	18	18	41	34
3	0	34	34	7	7	34	34
4	0	18	18	18	4	18	18
5	0	4	7	4	4	7	7
6	0	2	4	4	4	4	7
	0	1	2	3	4	5	6

$\times$

K_y

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

$34 * 1 + 34 * 2 + 7 * 1 = -27$

Edge detection computation at matrix element (2, 2)

0	0	0	0	0	0	0	0
1	0	34	34	34	34	41	18
2	0	34	34	18	18	41	34
3	0	34	34	7	7	34	34
4	0	18	18	18	4	18	18
5	0	4	7	4	4	7	7
6	0	2	4	4	4	4	7
	0	1	2	3	4	5	6

×

K_y

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

Element-wise multiplication

g_y = 34 * -1 + 34 * -2 + 34 * -1 +

34 * 0 + 34 * 0 + 18 * 0 +

34 * 1 + 34 * 2 + 7 * 1 = -27

Edge detection computation at matrix element (2, 2)

	0	1	2	3	4	5	6
0	0	0	0	0	0	0	0
1	0	34	34	34	34	41	18
2	0	34	34	18	18	41	34
3	0	34	34	7	7	34	34
4	0	18	18	18	4	18	18
5	0	4	7	4	4	7	7
6	0	2	4	4	4	4	7

$$G = \sqrt{g_x^2 + g_y^2}$$
$$= \sqrt{(-59)^2 + (-27)^2}$$
$$= 64.88$$

if $G \geq 255$ then $G = 255$

Edge detection computation at matrix element (2, 3)

	0	1	2	3	4	5	6
0	0	0	0	0	0	0	0
1	0	34	34	34	34	41	18
2	0	34	34	18	18	41	34
3	0	34	34	7	7	34	34
4	0	18	18	18	4	18	18
5	0	4	7	4	4	7	7
6	0	2	4	4	4	4	7

Edge detection computation at matrix element (2, 3)

	0	1	2	3	4	5	6
0	0	0	0	0	0	0	0
1	0	34	34	34	34	41	18
2	0	34	34	18	18	41	34
3	0	34	34	7	7	34	34
4	0	18	18	18	4	18	18
5	0	4	7	4	4	7	7
6	0	2	4	4	4	4	7

$\times$

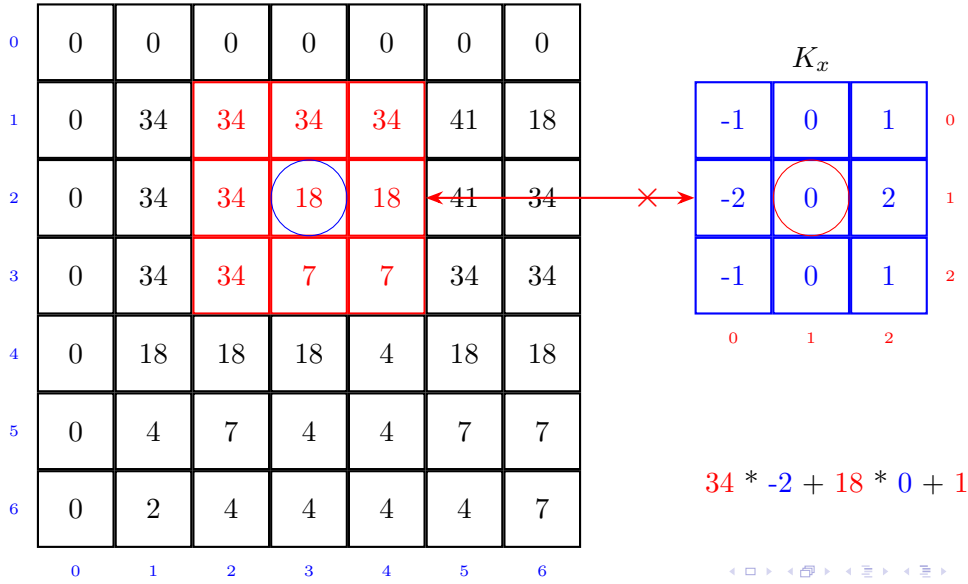
K_x

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

Element-wise multiplication

$g_x = 34 * -1 + 34 * 0 + 34 * 1 +$

Edge detection computation at matrix element (2, 3)



34 * -2 + 18 * 0 + 18 * 2 +

Edge detection computation at matrix element (2, 3)

	0	1	2	3	4	5	6
0	0	0	0	0	0	0	0
1	0	34	34	34	34	41	18
2	0	34	34	18	18	41	34
3	0	34	34	7	7	34	34
4	0	18	18	18	4	18	18
5	0	4	7	4	4	7	7
6	0	2	4	4	4	4	7

$\times$

K_x

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

34 * -1 + 7 * 0 + 7 * 1 = -59

Edge detection computation at matrix element (2, 3)

	0	1	2	3	4	5	6
0	0	0	0	0	0	0	0
1	0	34	34	34	34	41	18
2	0	34	34	18	18	41	34
3	0	34	34	7	7	34	34
4	0	18	18	18	4	18	18
5	0	4	7	4	4	7	7
6	0	2	4	4	4	4	7

$\times$

K_x

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

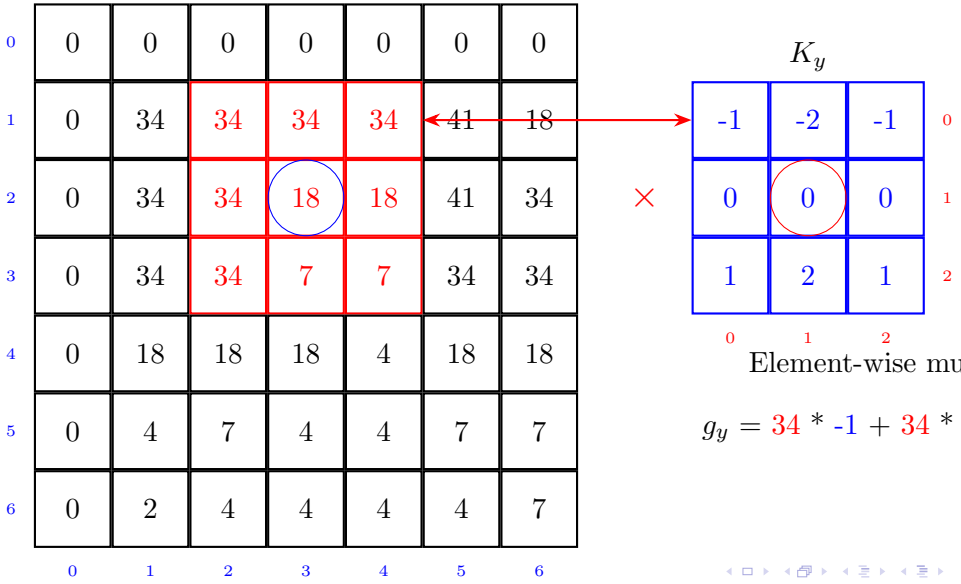
Element-wise multiplication

g_x = 34 * -1 + 34 * 0 + 34 * 1 +

34 * -2 + 18 * 0 + 18 * 2 +

34 * -1 + 7 * 0 + 7 * 1 = -59

Edge detection computation at matrix element (2, 3)



Edge detection computation at matrix element (2, 3)

	0	1	2	3	4	5	6
0	0	0	0	0	0	0	0
1	0	34	34	34	34	41	18
2	0	34	34	18	18	41	34
3	0	34	34	7	7	34	34
4	0	18	18	18	4	18	18
5	0	4	7	4	4	7	7
6	0	2	4	4	4	4	7

K_y

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

$34 * 0 + 18 * 0 + 18 * 0 +$

Edge detection computation at matrix element (2, 3)

	0	1	2	3	4	5	6
0	0	0	0	0	0	0	0
1	0	34	34	34	34	41	18
2	0	34	34	18	18	41	34
3	0	34	34	7	7	34	34
4	0	18	18	18	4	18	18
5	0	4	7	4	4	7	7
6	0	2	4	4	4	4	7

$\times$

K_y

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

$34 * 1 + 7 * 2 + 7 * 1 = -81$

Edge detection computation at matrix element (2, 3)

0	0	0	0	0	0	0	0
1	0	34	34	34	34	41	18
2	0	34	34	18	18	41	34
3	0	34	34	7	7	34	34
4	0	18	18	18	4	18	18
5	0	4	7	4	4	7	7
6	0	2	4	4	4	4	7
	0	1	2	3	4	5	6

$\times$

K_y

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

Element-wise multiplication

g_y = 34 * -1 + 34 * -2 + 34 * -1 +

34 * 0 + 18 * 0 + 18 * 0 +

34 * 1 + 7 * 2 + 7 * 1 = -81

Edge detection computation at matrix element (2, 3)

	0	1	2	3	4	5	6
0	0	0	0	0	0	0	0
1	0	34	34	34	34	41	18
2	0	34	34	18	18	41	34
3	0	34	34	7	7	34	34
4	0	18	18	18	4	18	18
5	0	4	7	4	4	7	7
6	0	2	4	4	4	4	7

$$G = \sqrt{g_x^2 + g_y^2}$$
$$= \sqrt{(-59)^2 + (-81)^2}$$
$$= 100.21$$

if $G \geq 255$ then $G = 255$

Edge detection computation at matrix element (3, 1)

	0	1	2	3	4	5	6
0	0	0	0	0	0	0	0
1	0	34	34	34	34	41	18
2	0	34	34	18	18	41	34
3	0	34	34	7	7	34	34
4	0	18	18	18	4	18	18
5	0	4	7	4	4	7	7
6	0	2	4	4	4	4	7

Edge detection computation at matrix element (3, 1)

	0	1	2	3	4	5	6
0	0	0	0	0	0	0	0
1	0	34	34	34	34	41	18
2	0	34	34	18	18	41	34
3	0	34	34	7	7	34	34
4	0	18	18	18	4	18	18
5	0	4	7	4	4	7	7
6	0	2	4	4	4	4	7

$\times$

K_x

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

Element-wise multiplication

$g_x = 0 * -1 + 34 * 0 + 34 * 1 +$

Edge detection computation at matrix element (3, 1)

	0	1	2	3	4	5	6
0	0	0	0	0	0	0	0
1	0	34	34	34	34	41	18
2	0	34	34	18	18	41	34
3	0	34	34	7	7	34	34
4	0	18	18	18	4	18	18
5	0	4	7	4	4	7	7
6	0	2	4	4	4	4	7

K_x

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

0 * -2 + 34 * 0 + 34 * 2 +

Edge detection computation at matrix element (3, 1)

	0	1	2	3	4	5	6
0	0	0	0	0	0	0	0
1	0	34	34	34	34	41	18
2	0	34	34	18	18	41	34
3	0	34	34	7	7	34	34
4	0	18	18	18	4	18	18
5	0	4	7	4	4	7	7
6	0	2	4	4	4	4	7

$\times$

K_x

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

$0 * -1 + 18 * 0 + 18 * 1 = 120$

Edge detection computation at matrix element (3, 1)

	0	1	2	3	4	5	6
0	0	0	0	0	0	0	0
1	0	34	34	34	34	41	18
2	0	34	34	18	18	41	34
3	0	34	34	7	7	34	34
4	0	18	18	18	4	18	18
5	0	4	7	4	4	7	7
6	0	2	4	4	4	4	7

$\times$

K_x

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

Element-wise multiplication

$g_x = 0 * -1 + 34 * 0 + 34 * 1 +$

$0 * -2 + 34 * 0 + 34 * 2 +$

$0 * -1 + 18 * 0 + 18 * 1 = 120$

Edge detection computation at matrix element (3, 1)

	0	1	2	3	4	5	6
0	0	0	0	0	0	0	0
1	0	34	34	34	34	41	18
2	0	34	34	18	18	41	34
3	0	34	34	7	7	34	34
4	0	18	18	18	4	18	18
5	0	4	7	4	4	7	7
6	0	2	4	4	4	4	7

$\times$

K_y

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

Element-wise multiplication

$g_y = 0 * -1 + 34 * -2 + 34 * -1 +$

Edge detection computation at matrix element (3, 1)

	0	1	2	3	4	5	6
0	0	0	0	0	0	0	0
1	0	34	34	34	34	41	18
2	0	34	34	18	18	41	34
3	0	34	34	7	7	34	34
4	0	18	18	18	4	18	18
5	0	4	7	4	4	7	7
6	0	2	4	4	4	4	7

K_y

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

$$0 * 0 + 34 * 0 + 34 * 0 +$$

Edge detection computation at matrix element (3, 1)

	0	1	2	3	4	5	6
0	0	0	0	0	0	0	0
1	0	34	34	34	34	41	18
2	0	34	34	18	18	41	34
3	0	34	34	7	7	34	34
4	0	18	18	18	4	18	18
5	0	4	7	4	4	7	7
6	0	2	4	4	4	4	7

$\times$

K_y

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

$0 * 1 + 18 * 2 + 18 * 1 = -48$

Edge detection computation at matrix element (3, 1)

	0	1	2	3	4	5	6
0	0	0	0	0	0	0	0
1	0	34	34	34	34	41	18
2	0	34	34	18	18	41	34
3	0	34	34	7	7	34	34
4	0	18	18	18	4	18	18
5	0	4	7	4	4	7	7
6	0	2	4	4	4	4	7

$\times$

K_y

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

Element-wise multiplication

g_y = 0 * -1 + 34 * -2 + 34 * -1 +

0 * 0 + 34 * 0 + 34 * 0 +

0 * 1 + 18 * 2 + 18 * 1 = -48

Edge detection computation at matrix element (3, 1)

	0	1	2	3	4	5	6
0	0	0	0	0	0	0	0
1	0	34	34	34	34	41	18
2	0	34	34	18	18	41	34
3	0	34	34	7	7	34	34
4	0	18	18	18	4	18	18
5	0	4	7	4	4	7	7
6	0	2	4	4	4	4	7

$$G = \sqrt{g_x^2 + g_y^2}$$
$$= \sqrt{(120)^2 + (-48)^2}$$
$$= 129.24$$

if $G \geq 255$ then $G = 255$

Edge detection computation at matrix element (3, 2)

	0	1	2	3	4	5	6
0	0	0	0	0	0	0	0
1	0	34	34	34	34	41	18
2	0	34	34	18	18	41	34
3	0	34	34	7	7	34	34
4	0	18	18	18	4	18	18
5	0	4	7	4	4	7	7
6	0	2	4	4	4	4	7

Edge detection computation at matrix element (3, 2)

	0	1	2	3	4	5	6
0	0	0	0	0	0	0	0
1	0	34	34	34	34	41	18
2	0	34	34	18	18	41	34
3	0	34	34	7	7	34	34
4	0	18	18	18	4	18	18
5	0	4	7	4	4	7	7
6	0	2	4	4	4	4	7

$\times$

K_x

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

Element-wise multiplication

$g_x = 34 * -1 + 34 * 0 + 18 * 1 +$

Edge detection computation at matrix element (3, 2)

0	0	0	0	0	0	0	0
1	0	34	34	34	34	41	18
2	0	34	34	18	18	41	34
3	0	34	34	7	7	34	34
4	0	18	18	18	4	18	18
5	0	4	7	4	4	7	7
6	0	2	4	4	4	4	7
	0	1	2	3	4	5	6

$\times$

K_x

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

0 1 2 (row indices) 0 1 2 (column indices)

34 * -2 + 34 * 0 + 7 * 2 +

Edge detection computation at matrix element (3, 2)

0	0	0	0	0	0	0	0
1	0	34	34	34	34	41	18
2	0	34	34	18	18	41	34
3	0	34	34	7	7	34	34
4	0	18	18	18	4	18	18
5	0	4	7	4	4	7	7
6	0	2	4	4	4	4	7
	0	1	2	3	4	5	6

$\times$

K_x

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

18 * -1 + 18 * 0 + 18 * 1 = -70

Edge detection computation at matrix element (3, 2)

0	0	0	0	0	0	0	0
1	0	34	34	34	34	41	18
2	0	34	34	18	18	41	34
3	0	34	34	7	7	34	34
4	0	18	18	18	4	18	18
5	0	4	7	4	4	7	7
6	0	2	4	4	4	4	7
	0	1	2	3	4	5	6

$\times$

K_x

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

Element-wise multiplication

g_x = 34 * -1 + 34 * 0 + 18 * 1 +

34 * -2 + 34 * 0 + 7 * 2 +

18 * -1 + 18 * 0 + 18 * 1 = -70

Edge detection computation at matrix element (3, 2)

	0	1	2	3	4	5	6
0	0	0	0	0	0	0	0
1	0	34	34	34	34	41	18
2	0	34	34	18	18	41	34
3	0	34	34	7	7	34	34
4	0	18	18	18	4	18	18
5	0	4	7	4	4	7	7
6	0	2	4	4	4	4	7

$\times$

K_y

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

Element-wise multiplication

$g_y = 34 * -1 + 34 * -2 + 18 * -1$

Edge detection computation at matrix element (3, 2)

0	0	0	0	0	0	0	0
1	0	34	34	34	34	41	18
2	0	34	34	18	18	41	34
3	0	34	34	7	7	34	34
4	0	18	18	18	4	18	18
5	0	4	7	4	4	7	7
6	0	2	4	4	4	4	7
	0	1	2	3	4	5	6

$\times$

K_y

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

$34 * 0 + 34 * 0 + 7 * 0 +$

Edge detection computation at matrix element (3, 2)

0	0	0	0	0	0	0	0
1	0	34	34	34	34	41	18
2	0	34	34	18	18	41	34
3	0	34	34	7	7	34	34
4	0	18	18	18	4	18	18
5	0	4	7	4	4	7	7
6	0	2	4	4	4	4	7
	0	1	2	3	4	5	6

$\times$

K_y

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

$18 * 1 + 18 * 2 + 18 * 1 = -48$

Edge detection computation at matrix element (3, 2)

0	0	0	0	0	0	0	0
1	0	34	34	34	34	41	18
2	0	34	34	18	18	41	34
3	0	34	34	7	7	34	34
4	0	18	18	18	4	18	18
5	0	4	7	4	4	7	7
6	0	2	4	4	4	4	7
	0	1	2	3	4	5	6

$\times$

K_y

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

Element-wise multiplication

g_y = 34 * -1 + 34 * -2 + 18 * -1 +

34 * 0 + 34 * 0 + 7 * 0 +

18 * 1 + 18 * 2 + 18 * 1 = -48

Edge detection computation at matrix element (3, 2)

	0	1	2	3	4	5	6
0	0	0	0	0	0	0	0
1	0	34	34	34	34	41	18
2	0	34	34	18	18	41	34
3	0	34	34	7	7	34	34
4	0	18	18	18	4	18	18
5	0	4	7	4	4	7	7
6	0	2	4	4	4	4	7

$$G = \sqrt{g_x^2 + g_y^2}$$
$$= \sqrt{(-70)^2 + (-48)^2}$$
$$= 84.88$$

if $G \geq 255$ then $G = 255$

Edge detection computation at matrix element (3, 3)

	0	1	2	3	4	5	6
0	0	0	0	0	0	0	0
1	0	34	34	34	34	41	18
2	0	34	34	18	18	41	34
3	0	34	34	7	7	34	34
4	0	18	18	18	4	18	18
5	0	4	7	4	4	7	7
6	0	2	4	4	4	4	7

Edge detection computation at matrix element (3, 3)

	0	1	2	3	4	5	6
0	0	0	0	0	0	0	0
1	0	34	34	34	34	41	18
2	0	34	34	18	18	41	34
3	0	34	34	7	7	34	34
4	0	18	18	18	4	18	18
5	0	4	7	4	4	7	7
6	0	2	4	4	4	4	7

$\times$

K_x

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

Element-wise multiplication

$g_x = 34 * -1 + 18 * 0 + 18 * 1 +$

Edge detection computation at matrix element (3, 3)

	0	1	2	3	4	5	6
0	0	0	0	0	0	0	0
1	0	34	34	34	34	41	18
2	0	34	34	18	18	41	34
3	0	34	34	7	7	34	34
4	0	18	18	18	4	18	18
5	0	4	7	4	4	7	7
6	0	2	4	4	4	4	7

$\times$

K_x

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

34 * -2 + 7 * 0 + 7 * 2 +

Edge detection computation at matrix element (3, 3)

	0	1	2	3	4	5	6
0	0	0	0	0	0	0	0
1	0	34	34	34	34	41	18
2	0	34	34	18	18	41	34
3	0	34	34	7	7	34	34
4	0	18	18	18	4	18	18
5	0	4	7	4	4	7	7
6	0	2	4	4	4	4	7

$\times$

K_x

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

18 * -1 + 18 * 0 + 4 * 1 = -84

Edge detection computation at matrix element (3, 3)

	0	1	2	3	4	5	6
0	0	0	0	0	0	0	0
1	0	34	34	34	34	41	18
2	0	34	34	18	18	41	34
3	0	34	34	7	7	34	34
4	0	18	18	18	4	18	18
5	0	4	7	4	4	7	7
6	0	2	4	4	4	4	7

$\times$

K_x

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

0 1 2

Element-wise multiplication

g_x = 34 * -1 + 18 * 0 + 18 * 1 +

34 * -2 + 7 * 0 + 7 * 2 +

18 * -1 + 18 * 0 + 4 * 1 = -84

Edge detection computation at matrix element (3, 3)

	0	1	2	3	4	5	6
0	0	0	0	0	0	0	0
1	0	34	34	34	34	41	18
2	0	34	34	18	18	41	34
3	0	34	34	7	7	34	34
4	0	18	18	18	4	18	18
5	0	4	7	4	4	7	7
6	0	2	4	4	4	4	7

$\times$

K_y

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

Element-wise multiplication

$g_y = 34 * -1 + 18 * -2 + 18 * -1$

Edge detection computation at matrix element (3, 3)

	0	1	2	3	4	5	6
0	0	0	0	0	0	0	0
1	0	34	34	34	34	41	18
2	0	34	34	18	18	41	34
3	0	34	34	7	7	34	34
4	0	18	18	18	4	18	18
5	0	4	7	4	4	7	7
6	0	2	4	4	4	4	7

$\times$

K_y

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

$34 * 0 + 7 * 0 + 7 * 0 +$

Edge detection computation at matrix element (3, 3)

0	0	0	0	0	0	0	0
1	0	34	34	34	34	41	18
2	0	34	34	18	18	41	34
3	0	34	34	7	7	34	34
4	0	18	18	18	4	18	18
5	0	4	7	4	4	7	7
6	0	2	4	4	4	4	7
	0	1	2	3	4	5	6

$\times$

K_y

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

$18 * 1 + 18 * 2 + 4 * 1 = -30$

Edge detection computation at matrix element (3, 3)

0	0	0	0	0	0	0	0
1	0	34	34	34	34	41	18
2	0	34	34	18	18	41	34
3	0	34	34	7	7	34	34
4	0	18	18	18	4	18	18
5	0	4	7	4	4	7	7
6	0	2	4	4	4	4	7
	0	1	2	3	4	5	6

$\times$

K_y

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

Element-wise multiplication

g_y = 34 * -1 + 18 * -2 + 18 * -1 +

34 * 0 + 7 * 0 + 7 * 0 +

18 * 1 + 18 * 2 + 4 * 1 = -30

Edge detection computation at matrix element (3, 3)

	0	1	2	3	4	5	6
0	0	0	0	0	0	0	0
1	0	34	34	34	34	41	18
2	0	34	34	18	18	41	34
3	0	34	34	7	7	34	34
4	0	18	18	18	4	18	18
5	0	4	7	4	4	7	7
6	0	2	4	4	4	4	7

$$G = \sqrt{g_x^2 + g_y^2}$$
$$= \sqrt{(-84)^2 + (-30)^2}$$
$$= 89.20$$

if $G \geq 255$ then $G = 255$