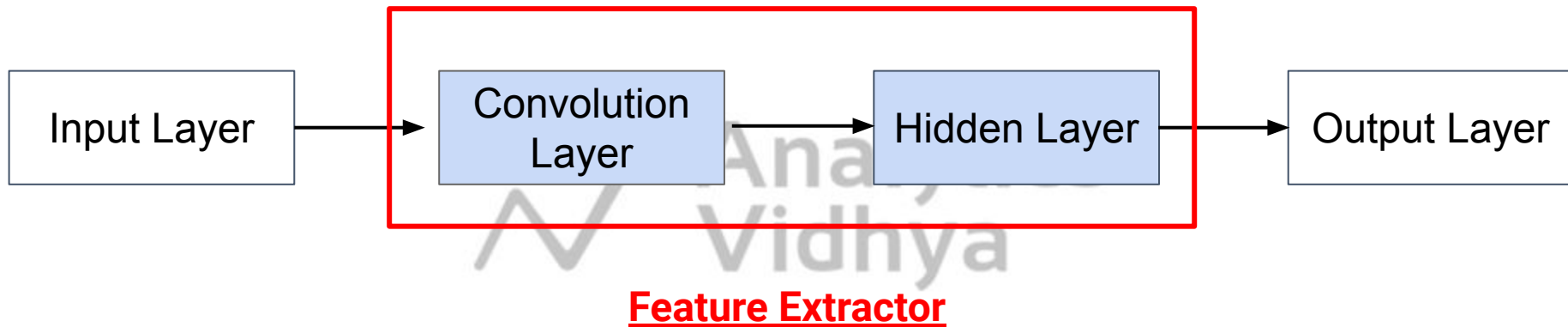


How do Filters Work?

Convolutional Neural Network



Feature Extraction using Filter



Original Gray Scale Image

filter



Vertical lines detected in
Image

Some Common Filters or Kernel

-1	0	1
-1	0	1
-1	0	1

Prewitt Kernel
X Direction

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

Sobel Kernel
X Direction

-1	-1	-1
0	0	0
1	1	1

Prewitt Kernel
Y Direction

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

Sobel Kernel
Y Direction

Filter Multiplication

36	31	28	24	23	27	33	39
38	34	29	26	25	30	37	41
39	35	32	28	27	33	40	43
42	38	34	30	30	36	43	46
43	40	36	32	34	40	48	50
44	41	37	35	37	43	51	52
45	42	39	37	41	46	53	54
45	42	40	39	42	48	54	55
43	42	39	40	43	49	55	57
41	41	38	39	44	49	55	58
38	39	37	40	44	49	55	58
34	37	36	39	43	48	54	56
31	35	35	39	44	49	53	55

Image

Filter Multiplication

-1	0	1
-1	0	1
-1	0	1

Filter

36	31	28	24	23	27	33	39
38	34	29	26	25	30	37	41
39	35	32	28	27	33	40	43
42	38	34	30	30	36	43	46
43	40	36	32	34	40	48	50
44	41	37	35	37	43	51	52
45	42	39	37	41	46	53	54
45	42	40	39	42	48	54	55
43	42	39	40	43	49	55	57
41	41	38	39	44	49	55	58
38	39	37	40	44	49	55	58
34	37	36	39	43	48	54	56
31	35	35	39	44	49	53	55

Image

Analytics
Vidhya

Filter Multiplication

$$= (36 \times -1) + (31 \times 0) + (28 \times 1) + (38 \times -1) + (34 \times 0) + (29 \times 1) + (39 \times -1) + (35 \times 0) + (32 \times 1)$$

-1	0	1
1	0	1
-1	0	1

Filter

36	31	28	24	23	27	28	39
38	34	29	26	25	30	37	41
39	35	32	28	27	33	40	43
42	38	34	30	30	36	43	46
43	40	36	32	34	40	48	50
44	41	37	35	37	43	51	52
45	42	39	37	41	46	53	54
45	42	40	39	42	48	54	55
43	42	39	40	43	49	55	57
41	41	38	39	44	49	55	58
38	39	37	40	44	49	55	58
34	37	36	39	43	48	54	56
31	35	35	39	44	49	53	55

Image

Filter Multiplication

$$= (36 \times -1) + (31 \times 0) + (28 \times 1) + (38 \times -1) + (34 \times 0) + (29 \times 1) + (39 \times -1) + (35 \times 0) + (32 \times 1)$$

-1	0	1
1	0	1
-1	0	1

Filter

36	31	28	24	23	27	28	39
38	34	29	26	25	30	37	41
39	35	32	28	27	33	40	43
42	38	34	30	30	36	43	46
43	40	36	32	34	40	48	50
44	41	37	35	37	43	51	52
45	42	39	37	41	46	53	54
45	42	40	39	42	48	54	55
43	42	39	40	43	49	55	57
41	41	38	39	44	49	55	58
38	39	37	40	44	49	55	58
34	37	36	39	43	48	54	56
31	35	35	39	44	49	53	55

Image

-24					

Feature Map

Column Stride

$$= (31 \times -1) + (28 \times 0) + (24 \times 1) + (34 \times -1) + (29 \times 0) + (26 \times 1) + (35 \times -1) + (32 \times 0) + (28 \times 1)$$

Column Stride = 1

36	31	28	24	23	27	33	39
38	34	29	26	25	30	37	41
39	35	32	28	27	33	40	43
42	38	34	30	30	36	43	46
43	40	36	32	34	40	48	50
44	41	37	35	37	43	51	52
45	42	39	37	41	46	53	54
45	42	40	39	42	48	54	55
43	42	39	40	43	49	55	57
41	41	38	39	44	49	55	58
38	39	37	40	44	49	55	58
34	37	36	39	43	48	54	56
31	35	35	39	44	49	53	55

-1	0	1
-1	0	1
-1	0	1

-24	-22				

Filter Multiplication

$$= (28 \times -1) + (24 \times 0) + (23 \times 1) + (29 \times -1) + (26 \times 0) + (25 \times 1) + (32 \times -1) + (28 \times 0) + (27 \times 1)$$

-1	0	1
-1	0	1
-1	0	1

36	31	28	24	23	27	33	38
38	34	29	26	25	30	37	41
39	35	32	28	27	33	40	43
42	38	34	30	30	36	43	46
43	40	36	32	34	40	48	50
44	41	37	35	37	43	51	52
45	42	39	37	41	46	53	54
45	42	40	39	42	48	54	55
43	42	39	40	43	49	55	57
41	41	38	39	44	49	55	58
38	39	37	40	44	49	55	58
34	37	36	39	43	48	54	56
31	35	35	39	44	49	53	55

-24	-22	-14			

Filter Multiplication

$$= (24 \times -1) + (23 \times 0) + (27 \times 1) + (26 \times -1) + (25 \times 0) + (30 \times 1) + (28 \times -1) + (27 \times 0) + (33 \times 1)$$

-1	0	1
-1	0	1
-1	0	1

36	31	28	24	23	27	33	39
38	34	29	26	25	30	37	41
39	35	32	28	27	33	40	43
42	38	34	30	30	36	43	46
43	40	36	32	34	40	48	50
44	41	37	35	37	43	51	52
45	42	39	37	41	46	53	54
45	42	40	39	42	48	54	55
43	42	39	40	43	49	55	57
41	41	38	39	44	49	55	58
38	39	37	40	44	49	55	58
34	37	36	39	43	48	54	56
31	35	35	39	44	49	53	55

-24	-22	-14	12		

Filter Multiplication

$$= (23 \times -1) + (27 \times 0) + (33 \times 1) + (25 \times -1) + (30 \times 0) + (37 \times 1) + (27 \times -1) + (33 \times 0) + (40 \times 1)$$

-1	0	1
-1	0	1
-1	0	1

36	31	28	24	23	27	33	39
38	34	29	26	25	30	37	41
39	35	32	28	27	33	40	43
42	38	34	30	30	36	43	46
43	40	36	32	34	40	48	50
44	41	37	35	37	43	51	52
45	42	39	37	41	46	53	54
45	42	40	39	42	48	54	55
43	42	39	40	43	49	55	57
41	41	38	39	44	49	55	58
38	39	37	40	44	49	55	58
34	37	36	39	43	48	54	56
31	35	35	39	44	49	53	55

-24	-22	-14	12	35	

Filter Multiplication

$$= (27 \times -1) + (33 \times 0) + (39 \times 1) + (30 \times -1) + (37 \times 0) + (41 \times 1) + (33 \times -1) + (40 \times 0) + (43 \times 1)$$

-1	0	1
-1	0	1
-1	0	1

36	31	28	24	23	27	33	39
38	34	29	26	25	30	37	41
39	35	32	28	27	33	40	43
42	38	34	30	30	36	43	46
43	40	36	32	34	40	48	50
44	41	37	35	37	43	51	52
45	42	39	37	41	46	53	54
45	42	40	39	42	48	54	55
43	42	39	40	43	49	55	57
41	41	38	39	44	49	55	58
38	39	37	40	44	49	55	58
34	37	36	39	43	48	54	56
31	35	35	39	44	49	53	55

-24	-22	-14	12	35	33

Row Stride

$$= (38 \times -1) + (34 \times 0) + (29 \times 1) + (39 \times -1) + (35 \times 0) + (32 \times 1) + (42 \times -1) + (38 \times 0) + (34 \times 1)$$

-1	0	1
-1	0	1
-1	0	1

Row Stride = 1

28	31	28	24	23	27	33	39
38	34	29	26	25	30	37	41
39	35	32	28	27	33	40	43
42	38	34	30	30	36	43	46
43	40	36	32	34	40	48	50
44	41	37	35	37	43	51	52
45	42	39	37	41	46	53	54
45	42	40	39	42	48	54	55
43	42	39	40	43	49	55	57
41	41	38	39	44	49	55	58
38	39	37	40	44	49	55	58
34	37	36	39	43	48	54	56
31	35	35	39	44	49	53	55

-24	-22	-14	12	35	33
-23					

Filter Multiplication

$$= (34 \times -1) + (29 \times 0) + (26 \times 1) + (35 \times -1) + (32 \times 0) + (28 \times 1) + (36 \times -1) + (34 \times 0) + (30 \times 1)$$

-1	0	1
-1	0	1
-1	0	1

36	31	28	24	22	27	33	39
38	34	29	26	25	30	37	41
39	35	32	28	27	33	40	43
42	38	34	30	28	36	43	46
43	40	36	32	34	40	48	50
44	41	37	35	37	43	51	52
45	42	39	37	41	46	53	54
45	42	40	39	42	48	54	55
43	42	39	40	43	49	55	57
41	41	38	39	44	49	55	58
38	39	37	40	44	49	55	58
34	37	36	39	43	48	54	56
31	35	35	39	44	49	53	55

-24	-22	-14	12	35	33
-23	-23				

Filter Multiplication

$$= (29 \times -1) + (26 \times 0) + (25 \times 1) + (32 \times -1) + (28 \times 0) + (27 \times 1) + (34 \times -1) + (30 \times 0) + (30 \times 1)$$

-1	0	1
-1	0	1
-1	0	1

36	31	28	24	23	27	33	39
38	34	29	26	25	30	37	41
39	35	32	28	27	33	40	43
42	38	34	30	30	36	43	46
43	40	36	32	34	40	48	50
44	41	37	35	37	43	51	52
45	42	39	37	41	46	53	54
45	42	40	39	42	48	54	55
43	42	39	40	43	49	55	57
41	41	38	39	44	49	55	58
38	39	37	40	44	49	55	58
34	37	36	39	43	48	54	56
31	35	35	39	44	49	53	55

-24	-22	-14	12	35	33
-23	-23	-13			

Filter Multiplication

$$= (26 \times -1) + (25 \times 0) + (30 \times 1) + (28 \times -1) + (27 \times 0) + (33 \times 1) + (30 \times -1) + (30 \times 0) + (36 \times 1)$$

-1	0	1
-1	0	1
-1	0	1

36	31	28	24	23	27	33	39
38	34	29	26	25	30	37	41
39	35	32	28	27	33	40	43
42	38	34	30	30	36	43	46
43	40	36	32	34	40	48	50
44	41	37	35	37	43	51	52
45	42	39	37	41	46	53	54
45	42	40	39	42	48	54	55
43	42	39	40	43	49	55	57
41	41	38	39	44	49	55	58
38	39	37	40	44	49	55	58
34	37	36	39	43	48	54	56
31	35	35	39	44	49	53	55

-24	-22	-14	12	35	33
-23	-23	-13	14		

Filter Multiplication

$$= (25 \times -1) + (30 \times 0) + (37 \times 1) + (27 \times -1) + (33 \times 0) + (40 \times 1) + (30 \times -1) + (36 \times 0) + (43 \times 1)$$

-1	0	1
-1	0	1
-1	0	1

36	31	28	24	23	27	33	39
38	34	29	26	25	30	37	41
39	35	32	28	27	33	40	43
42	38	34	30	30	36	43	46
43	40	36	32	34	40	48	50
44	41	37	35	37	43	51	52
45	42	39	37	41	46	53	54
45	42	40	39	42	48	54	55
43	42	39	40	43	49	55	57
41	41	38	39	44	49	55	58
38	39	37	40	44	49	55	58
34	37	36	39	43	48	54	56
31	35	35	39	44	49	53	55

-24	-22	-14	12	35	33
-23	-23	-13	14	39	

Filter Multiplication

$$= (30 \times -1) + (37 \times 0) + (41 \times 1) + (33 \times -1) + (40 \times 0) + (43 \times 1) + (56 \times -1) + (43 \times 0) + (46 \times 1)$$

-1	0	1
-1	0	1
-1	0	1

36	31	28	24	23	27	33	39
38	34	29	26	25	30	37	41
39	35	32	28	27	33	40	43
42	38	34	30	30	36	43	46
43	40	36	32	34	40	48	50
44	41	37	35	37	43	51	52
45	42	39	37	41	46	53	54
45	42	40	39	42	48	54	55
43	42	39	40	43	49	55	57
41	41	38	39	44	49	55	58
38	39	37	40	44	49	55	58
34	37	36	39	43	48	54	56
31	35	35	39	44	49	53	55

-24	-22	-14	12	35	33
-23	-23	-13	14	39	32

Filter Multiplication

$$= (38 \times -1) + (39 \times 0) + (37 \times 1) + (34 \times -1) + (37 \times 0) + (36 \times 1) + (31 \times -1) + (35 \times 0) + (35 \times 1)$$

-1	0	1
-1	0	1
-1	0	1

36	31	28	24	23	27	33	39
38	34	29	26	25	30	37	41
39	35	32	28	27	33	40	43
42	38	34	30	30	36	43	46
43	40	36	32	34	40	48	50
44	41	37	35	37	43	51	52
45	42	39	37	41	46	53	54
45	42	40	39	42	48	54	55
43	42	38	40	43	49	55	57
41	41	38	39	44	49	55	58
38	39	37	40	44	49	55	58
34	37	36	39	43	48	54	56
31	35	35	39	44	49	53	55

-24	-22	-14	12	35	33
-23	-23	-13	14	39	32
-22	-23	-11	18	41	31
-22	-23	-6	22	41	29
-20	-19	0	25	40	26
-18	-15	4	27	37	23
-15	-10	9	28	36	23
-13	-7	13	29	34	23
-8	-3	18	29	33	25
-2	2	20	28	32	25
5					

Filter Multiplication

$$= (39 \times -1) + (37 \times 0) + (40 \times 1) + (37 \times -1) + (36 \times 0) + (39 \times 1) + (35 \times -1) + (35 \times 0) + (39 \times 1)$$

-1	0	1
-1	0	1
-1	0	1

36	31	28	24	23	27	33	39
38	34	29	26	25	30	37	41
39	35	32	28	27	33	40	43
42	38	34	30	30	36	43	46
43	40	36	32	34	40	48	50
44	41	37	35	37	43	51	52
45	42	39	37	41	46	53	54
45	42	40	39	42	48	54	55
43	42	39	40	43	49	55	57
41	41	38	39	44	49	55	58
38	39	37	40	44	49	55	58
34	37	36	39	43	48	54	56
31	35	35	39	44	49	53	55

-24	-22	-14	12	35	33
-23	-23	-13	14	39	32
-22	-23	-11	18	41	31
-22	-23	-6	22	41	29
-20	-19	0	25	40	26
-18	-15	4	27	37	23
-15	-10	9	28	36	23
-13	-7	13	29	34	23
-8	-3	18	29	33	25
-2	2	20	28	32	25
5	8				

Filter Multiplication

$$= (37 \times -1) + (40 \times 0) + (44 \times 1) + (36 \times -1) + (39 \times 0) + (43 \times 1) + (35 \times -1) + (39 \times 0) + (44 \times 1)$$

-1	0	1
-1	0	1
-1	0	1

36	31	28	24	23	27	33	39
38	34	29	26	25	30	37	41
39	35	32	28	27	33	40	43
42	38	34	30	30	36	43	46
43	40	36	32	24	40	48	50
44	41	37	35	37	43	51	52
45	42	39	37	41	46	53	54
45	42	40	39	42	48	54	55
43	42	39	40	43	49	55	57
41	41	38	38	44	49	55	58
38	39	37	40	44	49	55	58
34	37	36	39	43	48	54	56
31	35	35	39	44	49	53	55

-24	-22	-14	12	35	33
-23	-23	-13	14	39	32
-22	-23	-11	18	41	31
-22	-23	-6	22	41	29
-20	-19	0	25	40	26
-18	-15	4	27	37	23
-15	-10	9	28	36	23
-13	-7	13	29	34	23
-8	-3	18	29	33	25
-2	2	20	28	32	25
5	8	23			

Filter Multiplication

$$= (40 \times -1) + (44 \times 0) + (49 \times 1) + (39 \times -1) + (43 \times 0) + (48 \times 1) + (39 \times -1) + (44 \times 0) + (49 \times 1)$$

-1	0	1
-1	0	1
-1	0	1

36	31	28	24	23	27	33	39
38	34	29	26	25	30	37	41
39	35	32	28	27	33	40	43
42	38	34	30	30	36	43	46
43	40	36	32	34	40	48	50
44	41	37	35	37	43	51	52
45	42	39	37	41	46	53	54
45	42	40	39	42	48	54	55
43	42	39	40	43	49	55	57
41	41	38	39	44	49	55	58
38	39	37	40	44	49	55	58
34	37	36	39	43	48	54	56
31	35	35	39	44	49	53	55

-24	-22	-14	12	35	33
-23	-23	-13	14	39	32
-22	-23	-11	18	41	31
-22	-23	-6	22	41	29
-20	-19	0	25	40	26
-18	-15	4	27	37	23
-15	-10	9	28	36	23
-13	-7	13	29	34	23
-8	-3	18	29	33	25
-2	2	20	28	32	25
5	8	23	28		

Filter Multiplication

$$= (44 \times -1) + (49 \times 0) + (55 \times 1) + (43 \times -1) + (48 \times 0) + (54 \times 1) + (44 \times -1) + (49 \times 0) + (53 \times 1)$$

-1	0	1
-1	0	1
-1	0	1

36	31	28	24	23	27	33	39
38	34	29	26	25	30	37	41
39	35	32	28	27	33	40	43
42	38	34	30	30	36	43	46
43	40	36	32	34	40	48	50
44	41	37	35	37	43	51	52
45	42	39	37	41	46	53	54
45	42	40	39	42	48	54	55
43	42	39	40	48	49	55	57
41	41	38	39	44	49	55	58
38	39	37	40	44	49	55	58
34	37	36	39	43	48	54	56
31	35	35	39	44	49	53	55

-24	-22	-14	12	35	33
-23	-23	-13	14	39	32
-22	-23	-11	18	41	31
-22	-23	-6	22	41	29
-20	-19	0	25	40	26
-18	-15	4	27	37	23
-15	-10	9	28	36	23
-13	-7	13	29	34	23
-8	-3	18	29	33	25
-2	2	20	28	32	25
5	8	23	28	30	

Filter Multiplication

$$= (49 \times -1) + (55 \times 0) + (58 \times 1) + (48 \times -1) + (54 \times 0) + (56 \times 1) + (49 \times -1) + (53 \times 0) + (55 \times 1)$$

-1	0	1
-1	0	1
-1	0	1

36	31	28	24	23	27	33	39
38	34	29	26	25	30	37	41
39	35	32	28	27	33	40	43
42	38	34	30	30	36	43	46
43	40	36	32	34	40	48	50
44	41	37	35	37	43	51	52
45	42	39	37	41	46	53	54
45	42	40	39	42	48	54	55
43	42	39	40	43	49	55	57
41	41	38	39	44	49	55	58
38	39	37	40	44	49	55	58
34	37	36	39	43	48	54	56
31	35	35	39	44	49	53	55

-24	-22	-14	12	35	33
-23	-23	-13	14	39	32
-22	-23	-11	18	41	31
-22	-23	-6	22	41	29
-20	-19	0	25	40	26
-18	-15	4	27	37	23
-15	-10	9	28	36	23
-13	-7	13	29	34	23
-8	-3	18	29	33	25
-2	2	20	28	32	25
5	8	23	28	30	23

Convolution using Filters

-1	0	1
-1	0	1
-1	0	1

Filter

36	31	28	24	23	27	33	39
38	34	29	26	25	30	37	41
39	35	32	28	27	33	40	43
42	38	34	30	30	36	43	46
43	40	36	32	34	40	48	50
44	41	37	35	37	43	51	52
45	42	39	37	41	46	53	54
45	42	40	39	42	48	54	55
43	42	39	40	43	49	55	57
41	41	38	39	44	49	55	58
38	39	37	40	44	49	55	58
34	37	36	39	43	48	54	56
31	35	35	39	44	49	53	55

Image

-24	-22	-14	12	35	33
-23	-23	-13	14	39	32
-22	-23	-11	18	41	31
-22	-23	-6	22	41	29
-20	-19	0	25	40	26
-18	-15	4	27	37	23
-15	-10	9	28	36	23
-13	-7	13	29	34	23
-8	-3	18	29	33	25
-2	2	20	28	32	25
5	8	23	28	30	23

Feature Map

Shapes with Single Filter

-1	0	1
-1	0	1
-1	0	1

3 X 3

36	31	28	24	23	27	33	39
38	34	29	26	25	30	37	41
39	35	32	28	27	33	40	43
42	38	34	30	30	36	43	46
43	40	36	32	34	40	48	50
44	41	37	35	37	43	51	52
45	42	39	37	41	46	53	54
45	42	40	39	42	48	54	55
43	42	39	40	43	49	55	57
41	41	38	39	44	49	55	58
38	39	37	40	44	49	55	58
34	37	36	39	43	48	54	56
31	35	35	39	44	49	53	55

13 X 8

-24	-22	-14	12	35	33
-23	-23	-13	14	39	32
-22	-23	-11	18	41	31
-22	-23	-6	22	41	29
-20	-19	0	25	40	26
-18	-15	4	27	37	23
-15	-10	9	28	36	23
-13	-7	13	29	34	23
-8	-3	18	29	33	25
-2	2	20	28	32	25
5	8	23	28	30	23

11 X 6

Convolution Operation in CNN

36	31	28	24	23	27	33	39
38	34	29	26	25	30	37	41
39	35	32	28	27	33	40	43
42	38	34	30	30	36	43	46
43	40	36	32	34	40	48	50
44	41	37	35	37	43	51	52
45	42	39	37	41	46	53	54
45	42	40	39	42	48	54	55
43	42	39	40	43	49	55	57
41	41	38	39	44	49	55	58
38	39	37	40	44	49	55	58
34	37	36	39	43	48	54	56
31	35	35	39	44	49	53	55

Image

-1	0	1
-1	0	1
-1	0	1

Filter

Convolution Operation in CNN

36	31	28	24	23	27	33	39
38	34	29	26	25	30	37	41
39	35	32	28	27	33	40	43
42	38	34	30	30	36	43	46
43	40	36	32	34	40	48	50
44	41	37	35	37	43	51	52
45	42	39	37	41	46	53	54
45	42	40	39	42	48	54	55
43	42	39	40	43	49	55	57
41	41	38	39	44	49	55	58
38	39	37	40	44	49	55	58
34	37	36	39	43	48	54	56
31	35	35	39	44	49	53	55

Image

-24	-22	-14	12	35	33
-23	-23	-13	14	39	32
-22	-23	-11	18	41	31
-22	-23	-6	22	41	29
-20	-19	0	25	40	26
-18	-15	4	27	37	23
-15	-10	9	28	36	23
-13	-7	13	29	34	23
-8	-3	18	29	33	25
-2	2	20	28	32	25
5	8	23	28	30	23

Feature Map

Convolution Operation in CNN

36	31	28	24	23	27	33	39
38	34	29	26	25	30	37	41
39	35	32	28	27	33	40	43
42	38	34	30	30	36	43	46
43	40	36	32	34	40	48	50
44	41	37	35	37	43	51	52
45	42	39	37	41	46	53	54
45	42	40	39	42	48	54	55
43	42	39	40	43	49	55	57
41	41	38	39	44	49	55	58
38	39	37	40	44	49	55	58
34	37	36	39	43	48	54	56
31	35	35	39	44	49	53	55

Image

-1	0	1
-1	0	1
-1	0	1

Filter

-24	-22	-15	12	35	33
-23	-23	-13	14	39	32
-22	-23	-11	18	41	31
-22	-23	-6	22	41	29
-20	-19	0	25	40	26
-18	-15	4	27	37	23
-15	-10	9	28	36	23
-13	-7	13	29	34	23
-8	-3	18	29	33	25
-2	2	20	28	32	25
5	8	23	28	30	23

Feature Map

Convolution Operation in CNN

X	X	X						
X	36	31	28	24	23	27	33	39
X	38	34	29	26	25	30	37	41
X	39	35	32	28	27	33	40	43
	42	38	34	30	30	36	43	46
	43	40	36	32	34	40	48	50
	44	41	37	35	37	43	51	52
	45	42	39	37	41	46	53	54
	45	42	40	39	42	48	54	55
	43	42	39	40	43	49	55	57
	41	41	38	39	44	49	55	58
	38	39	37	40	44	49	55	58
	34	37	36	39	43	48	54	56
	31	35	35	39	44	49	53	55

Image

-1	0	1
-1	0	1
-1	0	1

Filter

-24	-22	-14	12	35	33
-23	-23	-13	14	39	32
-22	-23	-11	18	41	31
-22	-23	-6	22	41	29
-20	-19	0	25	40	26
-18	-15	4	27	37	23
-15	-10	9	28	36	23
-13	-7	13	29	34	23
-8	-3	18	29	33	25
-2	2	20	28	32	25
5	8	23	28	30	23

Feature Map

Padding Operation in CNN

	0	0	0	0	0	0	0	0	
0	36	31	28	24	23	27	33	39	0
0	38	34	29	26	25	30	37	41	0
0	39	35	32	28	27	33	40	43	0
0	42	38	34	30	30	36	43	46	0
0	43	40	36	32	34	40	48	50	0
0	44	41	37	35	37	43	51	52	0
0	45	42	39	37	41	46	53	54	0
0	45	42	40	39	42	48	54	55	0
0	43	42	39	40	43	49	55	57	0
0	41	41	38	39	44	49	55	58	0
0	38	39	37	40	44	49	55	58	0
0	34	37	36	39	43	48	54	56	0
0	31	35	35	39	44	49	53	55	0
	0	0	0	0	0	0	0	0	

Image

-1	0	1
-1	0	1
-1	0	1

Filter

Padding Strategies



Padding Strategies

Same

Padding

	0	0	0	0	0	0	0	0	
0	36	31	28	24	23	27	33	39	0
0	38	34	29	26	25	30	37	41	0
0	39	35	32	28	27	33	40	43	0
0	42	38	34	30	30	36	43	46	0
0	43	40	36	32	34	40	48	50	0
0	44	41	37	35	37	43	51	52	0
0	45	42	39	37	41	46	53	54	0
0	45	42	40	39	42	48	54	55	0
0	43	42	39	40	43	49	55	57	0
0	41	41	38	39	44	49	55	58	0
0	38	39	37	40	44	49	55	58	0
0	34	37	36	39	43	48	54	56	0
0	31	35	35	39	44	49	53	55	0
	0	0	0	0	0	0	0	0	

Image

-1	0	1
-1	0	1
-1	0	1

Filter

Padding Strategies

Same

Padding

Valid

No Padding

36	31	28	24	23	27	33	39
38	34	29	26	25	30	37	41
39	35	32	28	27	33	40	43
42	38	34	30	30	36	43	46
43	40	36	32	34	40	48	50
44	41	37	35	37	43	51	52
45	42	39	37	41	46	53	54
45	42	40	39	42	48	54	55
43	42	39	40	43	49	55	57
41	41	38	39	44	49	55	58
38	39	37	40	44	49	55	58
34	37	36	39	43	48	54	56
31	35	35	39	44	49	53	55

Image

-1	0	1
-1	0	1
-1	0	1

Filter

Shapes with Single Filter

-1	0	1
-1	0	1
-1	0	1

3 X 3

36	31	28	24	23	27	33	39
38	34	29	26	25	30	37	41
39	35	32	28	27	33	40	43
42	38	34	30	30	36	43	46
43	40	36	32	34	40	48	50
44	41	37	35	37	43	51	52
45	42	39	37	41	46	53	54
45	42	40	39	42	48	54	55
43	42	39	40	43	49	55	57
41	41	38	39	44	49	55	58
38	39	37	40	44	49	55	58
34	37	36	39	43	48	54	56
31	35	35	39	44	49	53	55

13 X 8

-24	-22	-14	12	35	33
-23	-23	-13	14	39	32
-22	-23	-11	18	41	31
-22	-23	-6	22	41	29
-20	-19	0	25	40	26
-18	-15	4	27	37	23
-15	-10	9	28	36	23
-13	-7	13	29	34	23
-8	-3	18	29	33	25
-2	2	20	28	32	25
5	8	23	28	30	23

11 X 6

Calculating shape of Feature Map

$$OutputHeight = \frac{InputHeight - FilterHeight}{RowStride} + 1$$

$$OutputWidth = \frac{InputWidth - FilterWidth}{ColumnStride} + 1$$



Thank You!