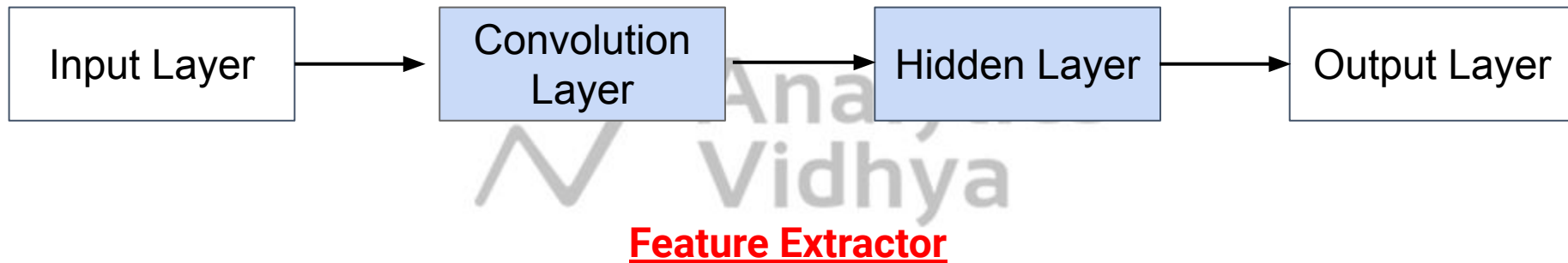


Parameter Sharing and Local Connectivity

Convolutional Neural Network



Convolution Operation in CNN

-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

- Local Connectivity

- Parameter Sharing



Local Connectivity



Local Connectivity

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					

Feature Map

Local Connectivity

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				

Feature Map

Local Connectivity

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			

Feature Map

Local Connectivity

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

Image

-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

Local Connectivity

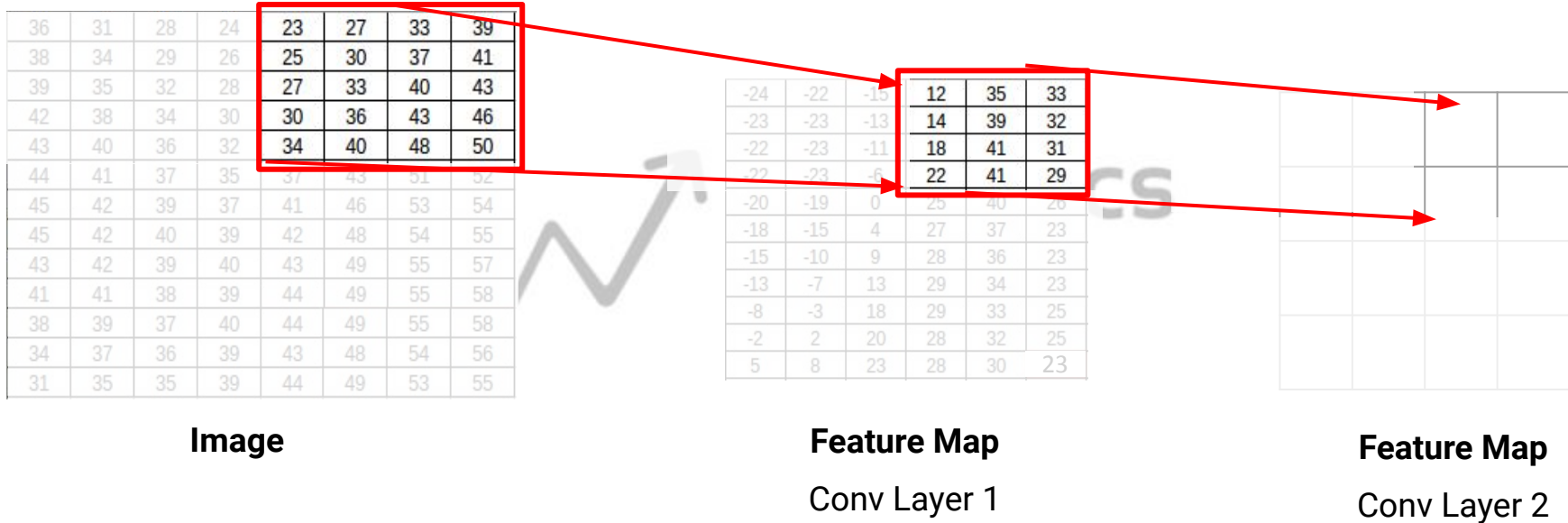
36	31	28	24	23	27	33	39
38	34	29	26	25	30	37	41
39	35	32	28	27	33	40	43
42	38	34	30	30	36	43	46
43	40	36	32	34	40	48	50
44	41	37	35	37	43	51	52
45	42	39	37	41	46	53	54
45	42	40	39	42	48	54	55
43	42	39	40	43	49	55	57
41	41	38	39	44	49	55	58
38	39	37	40	44	49	55	58
34	37	36	39	43	48	54	56
31	35	35	39	44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

Image

-24	-22	-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

Local Connectivity



Local Connectivity

Each output value takes input from a (small) local group of pixel values from the complete image.

36	31	28	24	23	27	33	39	-24	-22	-18	12	35	33
38	34	29	26	25	30	37	41	-23	-23	-13	14	39	32
39	35	32	28	27	33	40	43	-22	-23	-11	18	41	31
42	38	34	30	30	36	43	46	-22	-23	-6	22	41	29
43	40	36	32	34	40	48	50	-20	-19	0	25	40	26
44	41	37	35	37	43	51	52	-18	-15	4	27	37	23
45	42	39	37	41	46	53	54	-15	-10	9	28	36	23
45	42	40	39	42	48	54	55	-13	-7	13	29	34	23
43	42	39	40	43	49	55	57	-8	-3	18	29	33	25
41	41	38	39	44	49	55	58	-2	2	20	28	32	23
38	39	37	40	44	49	55	58	5	8	23	28	30	23
34	37	36	39	43	48	54	56						
31	35	35	39	44	49	53	55						

Input Image

Feature Map

Parameter Sharing



Parameter Sharing

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

-24					

Feature Map

Parameter Sharing

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

-24	-22				

Feature Map

Parameter Sharing

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

-24	-22	-14			

Feature Map

Parameter Sharing

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

-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				

Feature Map

Parameter Sharing

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

-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			

Feature Map

Parameter Sharing

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

-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		

Feature Map

Parameter Sharing



Parameter Sharing

Parameter sharing is sharing of filter values by all pixel values of the image to generate a particular feature map.



Local Connectivity & Parameter Sharing

- **Local Connectivity:** Each output value takes input from a (small) local group of pixel values from the complete image.
- **Parameter Sharing:** Parameter sharing is sharing of filter values by all pixel values of the image to generate a particular feature map.



Thank You!