

Computer Vision with Embedded Machine Learning

Review of Module 2

Image

57	59	58	67	82
63	66	75	100	124
61	69	89	121	150
71	96	126	145	157

stride = 1

Kernel

0	-1	0
-1	5	-1
0	-1	0

$$\begin{aligned}
 &(75 \cdot 0) + (100 \cdot -1) + (124 \cdot 0) + \\
 &(89 \cdot -1) + (121 \cdot 5) + (150 \cdot -1) + \\
 &(126 \cdot 0) + (145 \cdot -1) + (157 \cdot 0) = 121
 \end{aligned}$$

Output

64	62	113
33	54	121

$$O(i, j) = \sum_{m=0}^{M-1} \sum_{n=0}^{N-1} I((s \cdot i) + m, (s \cdot j) + n) \cdot K(m, n)$$

I_{00}	I_{01}	I_{02}	I_{03}	I_{04}
I_{10}	I_{11}	I_{12}	I_{13}	I_{14}
I_{20}	I_{21}	I_{22}	I_{23}	I_{24}
I_{30}	I_{31}	I_{32}	I_{33}	I_{34}

K_{00}	K_{01}	K_{02}
K_{10}	K_{11}	K_{12}
K_{20}	K_{21}	K_{22}

O_{00}	O_{01}	O_{02}
O_{10}	O_{11}	O_{12}

with stride = 1

0	0	0	0	0	0	0
0	57	59	58	67	82	0
0	63	66	75	100	124	0
0	61	69	89	121	150	0
0	71	96	126	145	157	0
0	0	0	0	0	0	0

Original image
(200x130)



Gaussian blur

1/16	1/8	1/16
1/8	1/4	1/8
1/16	1/8	1/16



Sharpen

0	-1	0
-1	5	-1
0	-1	0



Emboss

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



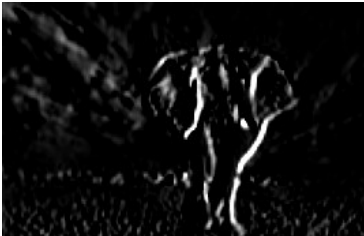
Outline

-1	-1	-1
-1	8	-1
-1	-1	-1



Left Sobel

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



Top Sobel

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



Average Pooling

Image

57	59	58	67	82
63	66	75	100	124
61	69	89	121	150
71	96	126	145	157

Window: 2x2

Stride: 2

Find average under window:

$$(89 + 121 + 126 + 145) / 4 = 120.25$$

Output

61	75
74	120

Max Pooling

Image

57	59	58	67	82
63	66	75	100	124
61	69	89	121	150
71	96	126	145	157

Window: 2x2

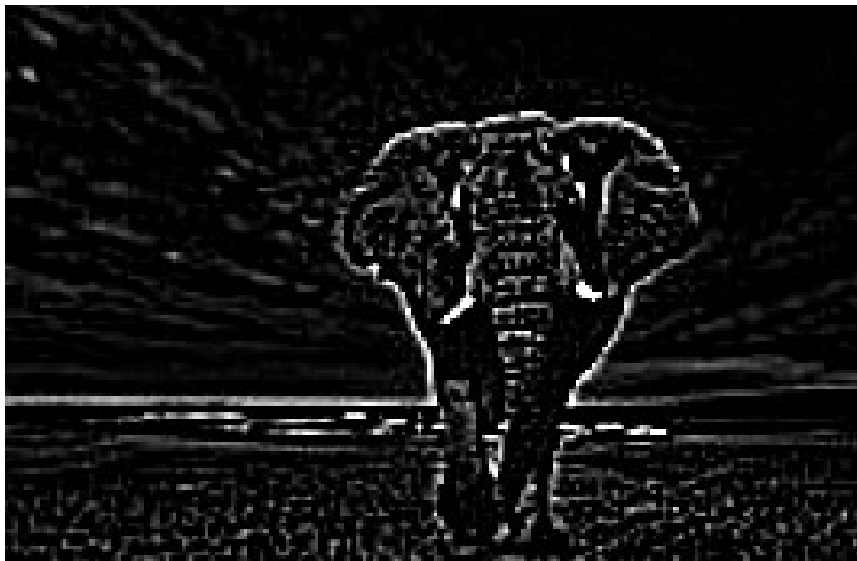
Stride: 2

Find maximum value under window: 145

Output

66	100
96	145

Filtered image
(198x128)



Average
Pooling

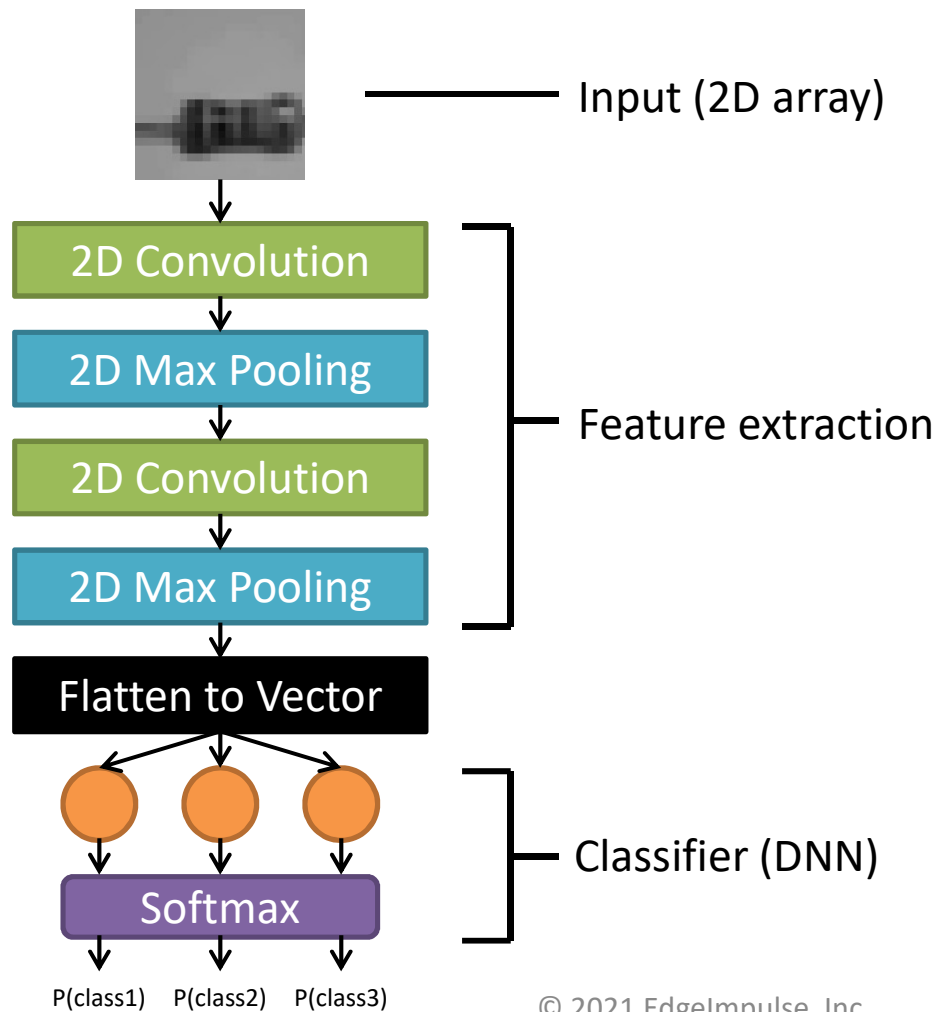
(99x64)



Max
Pooling

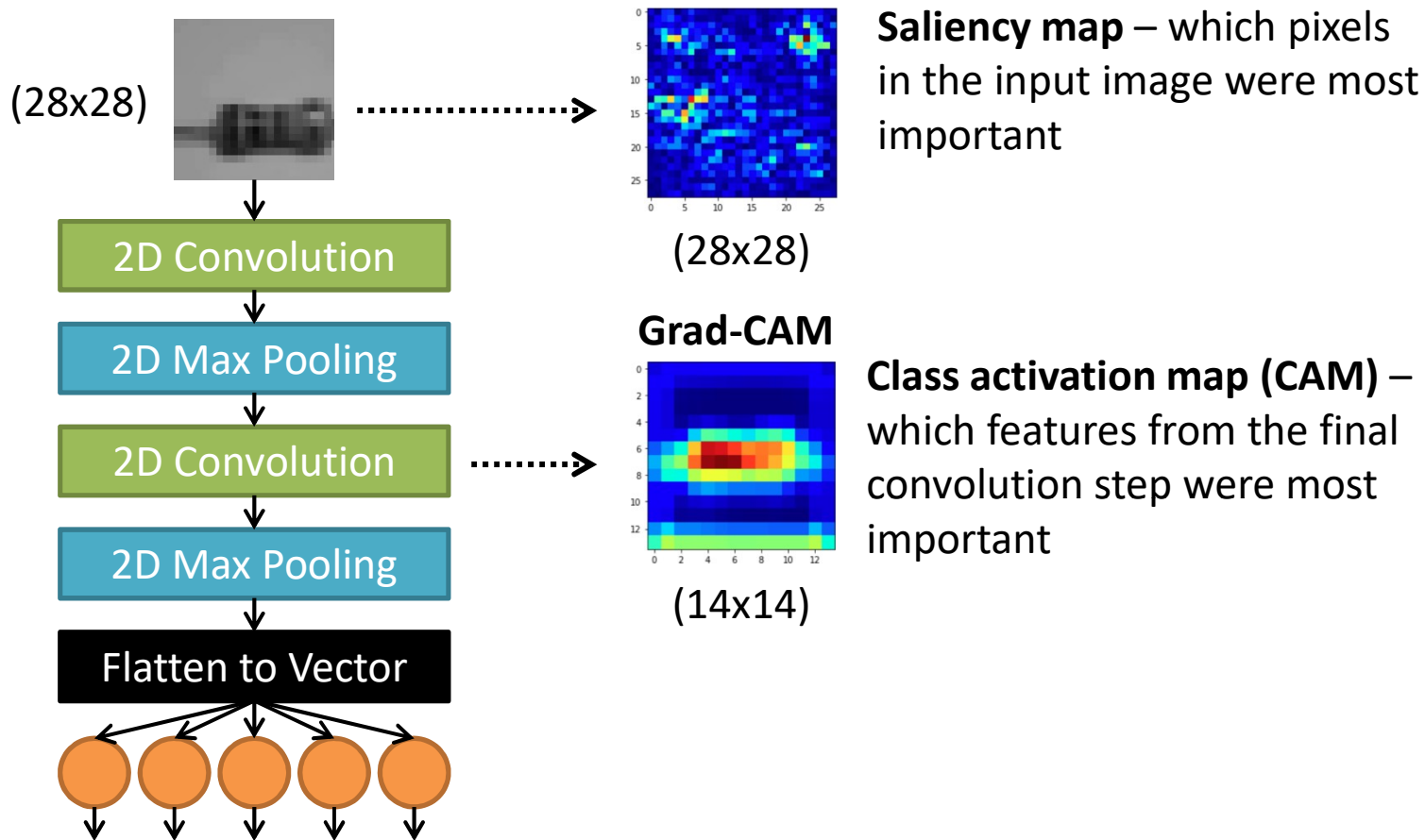
(99x64)



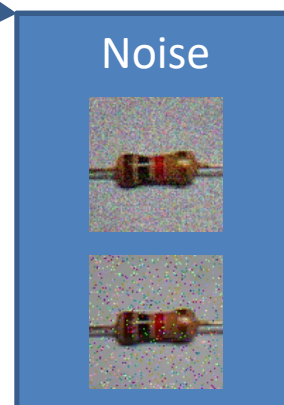
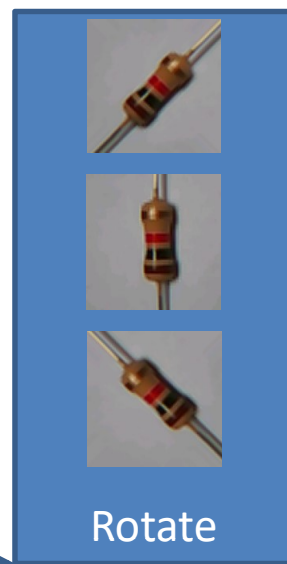
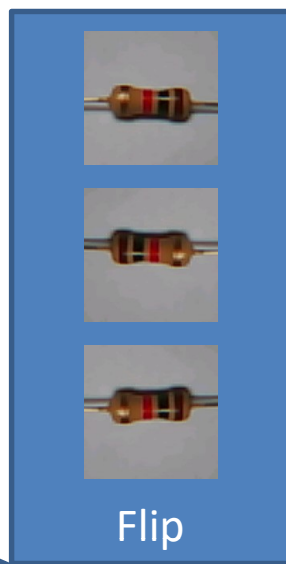
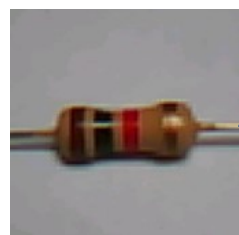


Popular input formats:

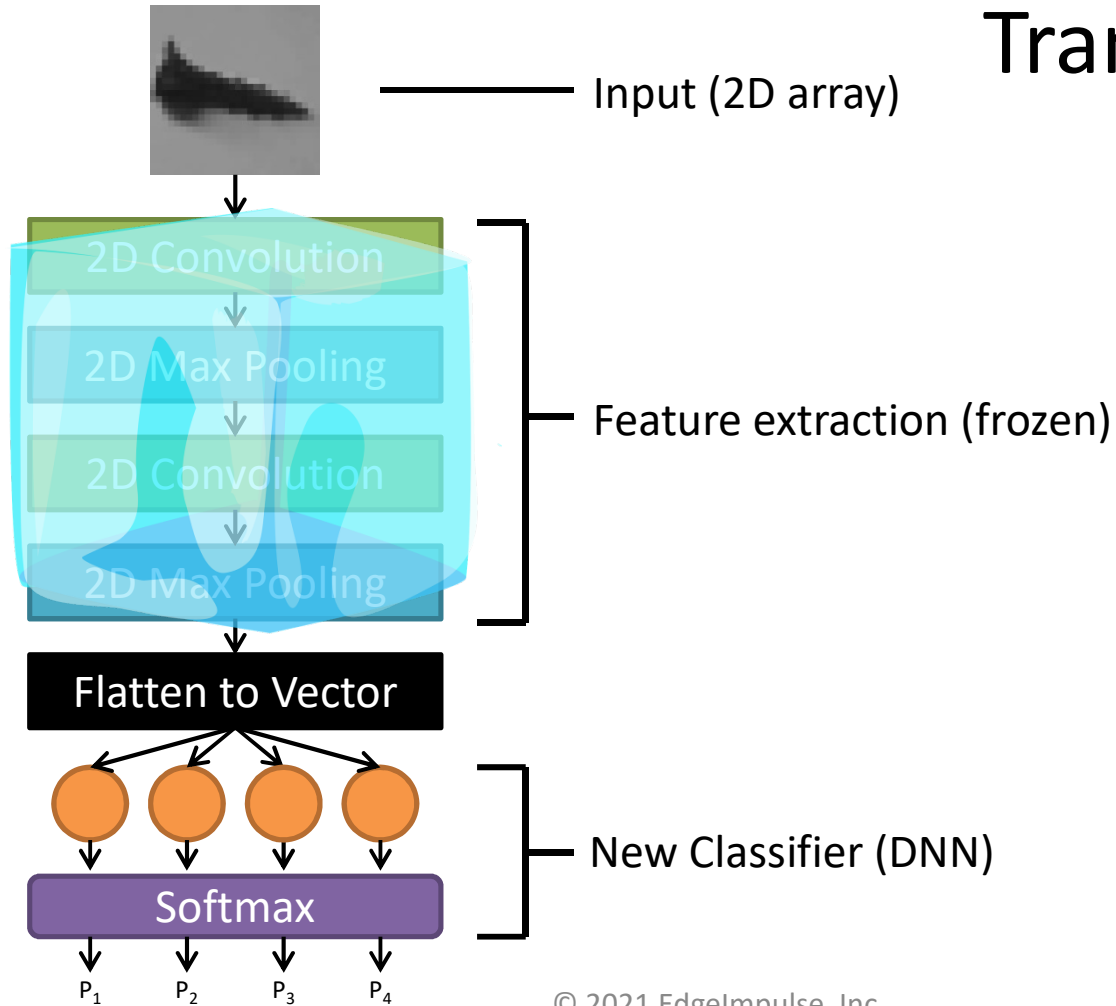
- Float [0.0..1.0]
- UInt8 [0..255]
- Int8 [-128..127]



1 image \rightarrow 13 images
250 images \rightarrow 3250 images



Transfer Learning



Fine-Tuning

