Fundamentals of Deep Learning

Part 3: Convolutional Neural Networks

Agenda

- Part 1: An Introduction to Deep Learning
- Part 2: How a Neural Network Trains
- Part 3: Convolutional Neural Networks
- Part 4: Data Augmentation and Deployment
- Part 5: Pre-Trained Models
- Part 6: Advanced Architectures

Recap of the exercise

Trained a dense neural network model

Training accuracy was high

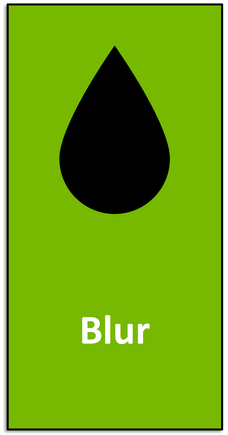
Validation accuracy was low

Evidence of overfitting

Kernels and Convolution

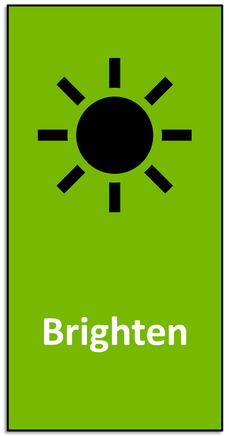
Kernels and Convolution

Original Image



Blur

Sharpen

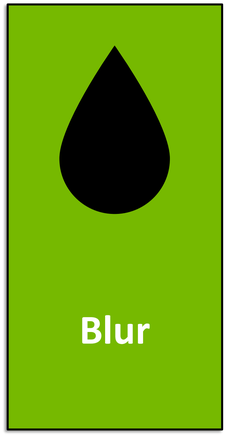


Brighten

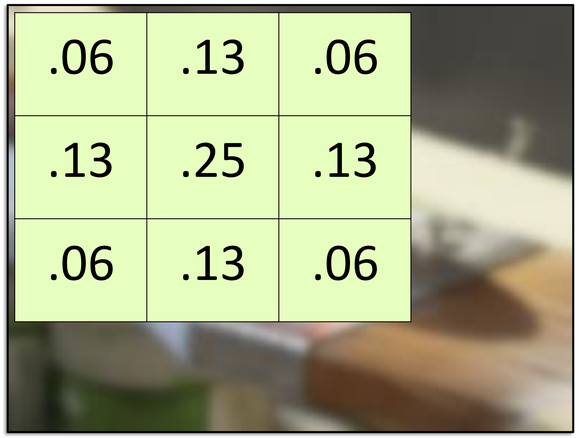
Darken

Kernels and Convolution

Original Image

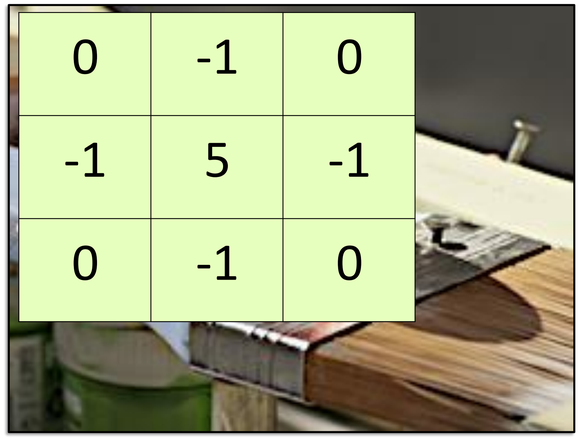


Blur



.06	.13	.06
.13	.25	.13
.06	.13	.06

Sharpen



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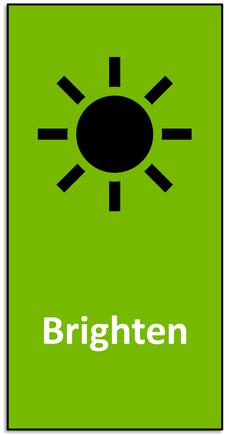
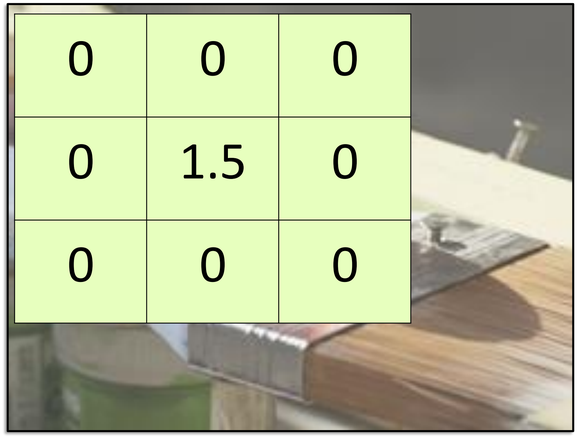
-1	5	-1
0	-1	0



Brighten



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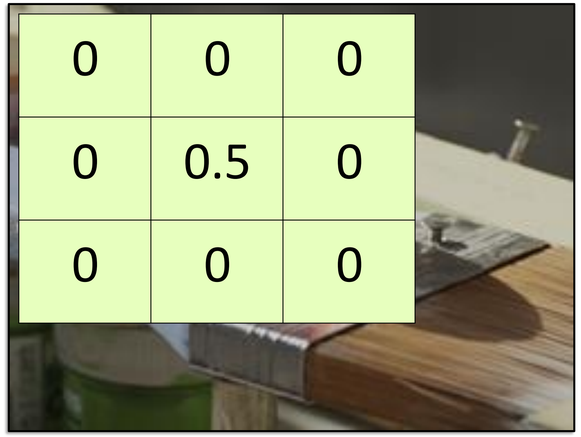
0	0	0

Darken



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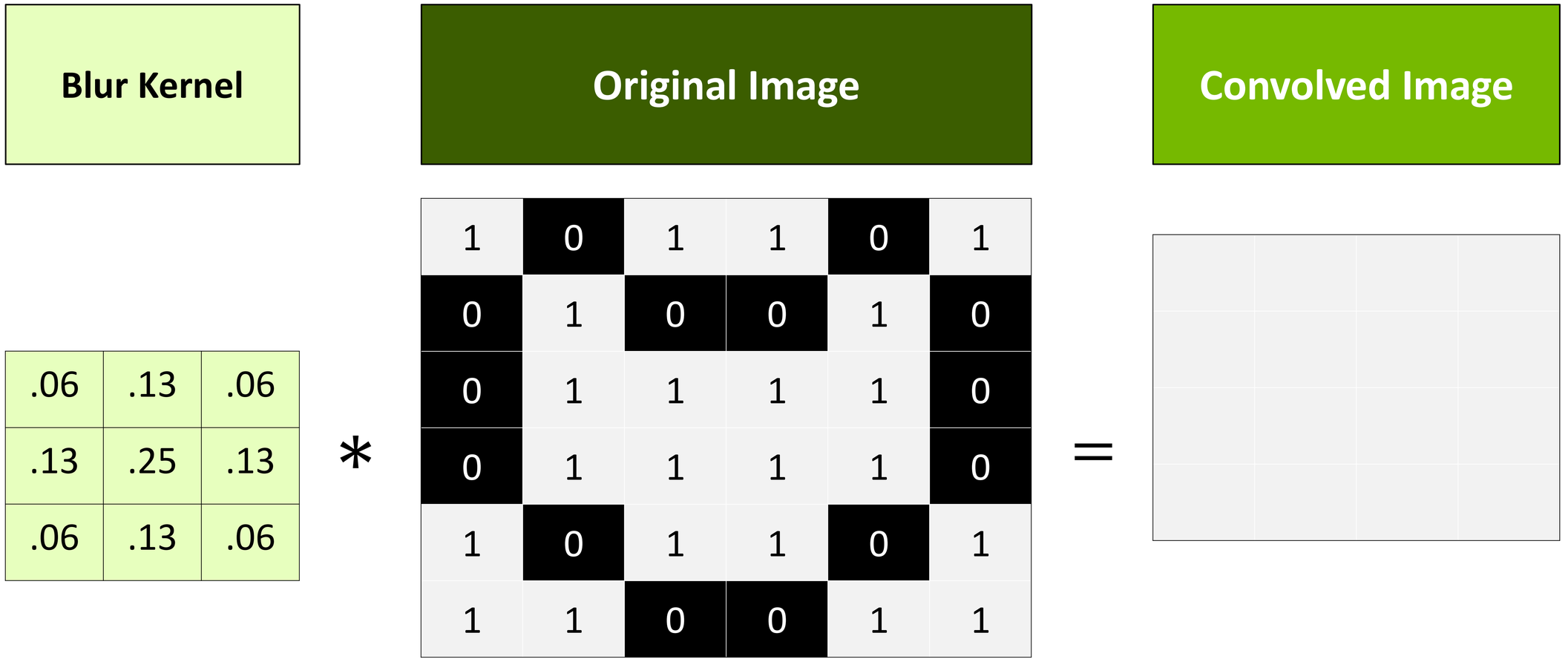
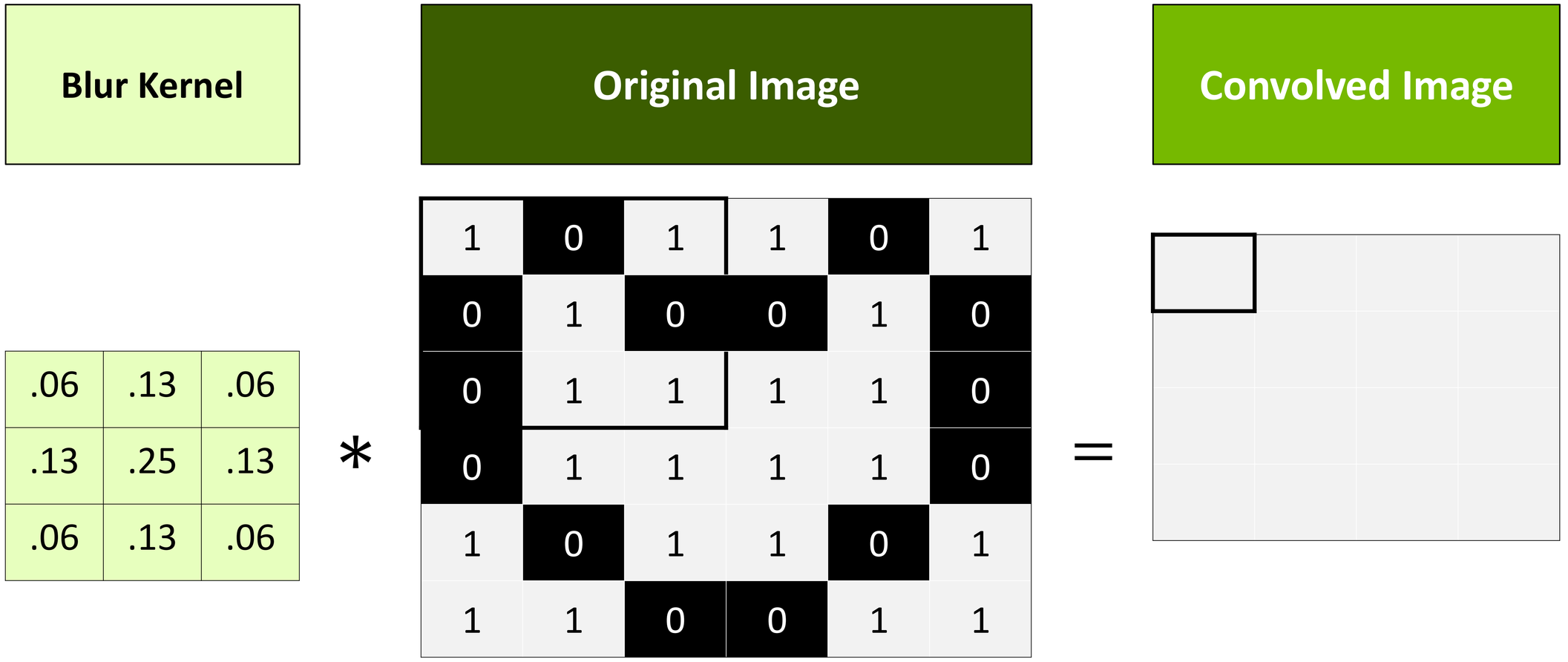
0	0.5	0
0	0	0

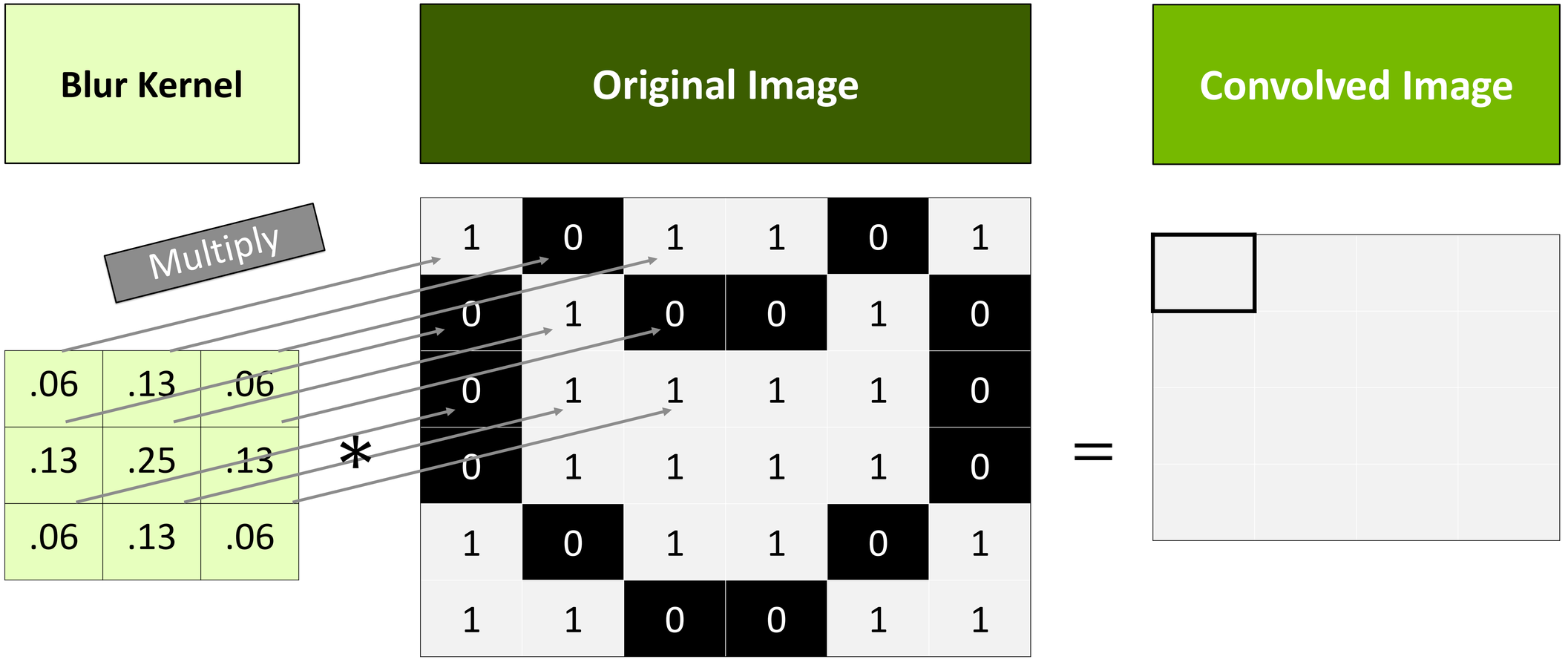
Kernels and Convolution



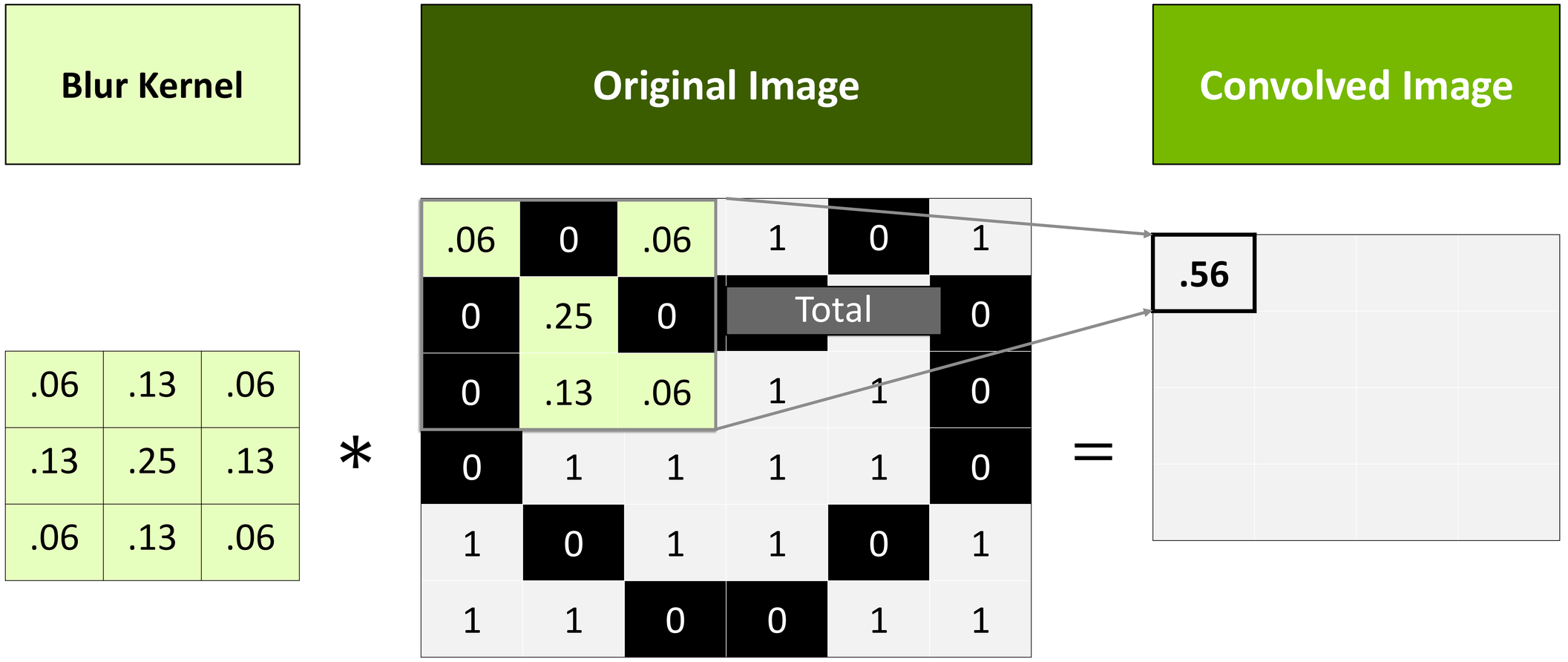
Kernels and Convolution



Kernels and Convolution



Kernels and Convolution



Kernels and Convolution

Blur Kernel

.06	.13	.06
.13	.25	.13
.06	.13	.06

*

Original Image

1	0	.13	.06	0	1
0	.13	0	0	1	0
0	.06	.13	.06	1	0
0	1	1	1	1	0
1	0	1	1	0	1
1	1	0	0	1	1

=

Convolved Image

.56	**.57**		

Kernels and Convolution

Blur Kernel

.06	.13	.06
.13	.25	.13
.06	.13	.06

*

Original Image

1	0	1	1	0	1
0	1	0	0	1	0
0	1	1	1	1	0
0	1	1	1	1	0
1	0	1	1	0	1
1	1	0	0	1	1

=

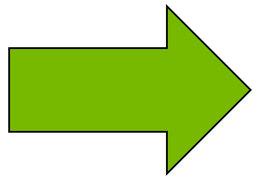
Convolved Image

.56	.57	.57	.56
.7	.82	.82	.7
.69	.95	.95	.69
.64	.69	.69	.64

Stride

Stride 1

1	0	1	1	0	1
0	1	0	0	1	0
0	1	1	1	1	0



.56	.57	.57	.56

Stride 2

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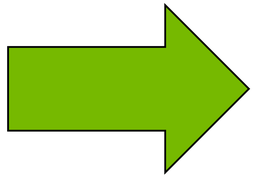
0	1	1	1	1	0



.56	.57

Stride 3

1	0	1	1	0	1
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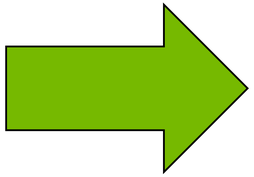
0	1	1	1	1	0



.56	.56

Padding

Original Image

1	0	1	1	0	1
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0	1	1	1	1	0
0	1	1	1	1	0
1	0	1	1	0	1
1	1	0	0	1	1

Zero Padding

0	0	0	0	0	0	0	0
0	1	0	1	1	0	1	0
0	0	1	0	0	1	0	0
0	0	1	1	1	1	0	0
0	0	1	1	1	1	0	0
0	1	0	1	1	0	1	0
0	1	1	0	0	1	1	0
0	0	0	0	0	0	0	0

Padding

Original Image

1	0	1	1	0	1
0	1	0	0	1	0
0	1	1	1	1	0
0	1	1	1	1	0
1	0	1	1	0	1
1	1	0	0	1	1

Mirror Padding

1	1	0	1	1	0	1	1
1	1	0	1	1	0	1	1
0	0	1	0	0	1	0	0
0	0	1	1	1	1	0	0
0	0	1	1	1	1	0	0
1	1	0	1	1	0	1	1
1	1	1	0	0	1	1	1
1	1	1	0	0	1	1	1

Kernels and Neural Networks

Kernels and Neural Networks

Kernel

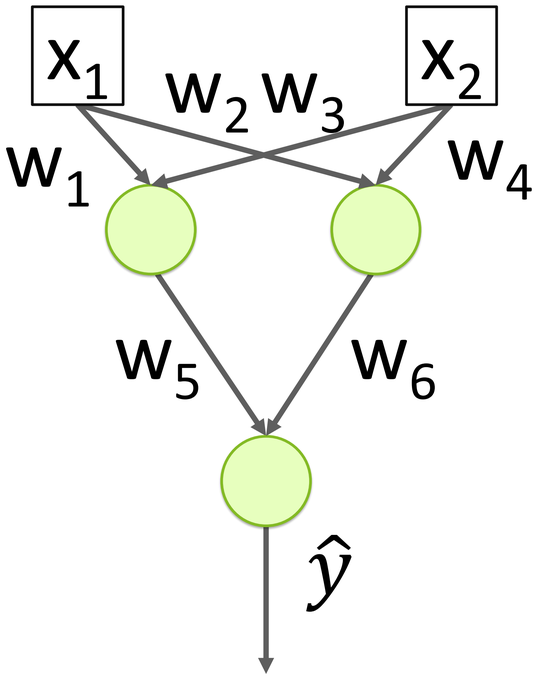
w_1	w_2	w_3
w_4	w_5	w_6
w_7	w_8	w_9

Kernels and Neural Networks

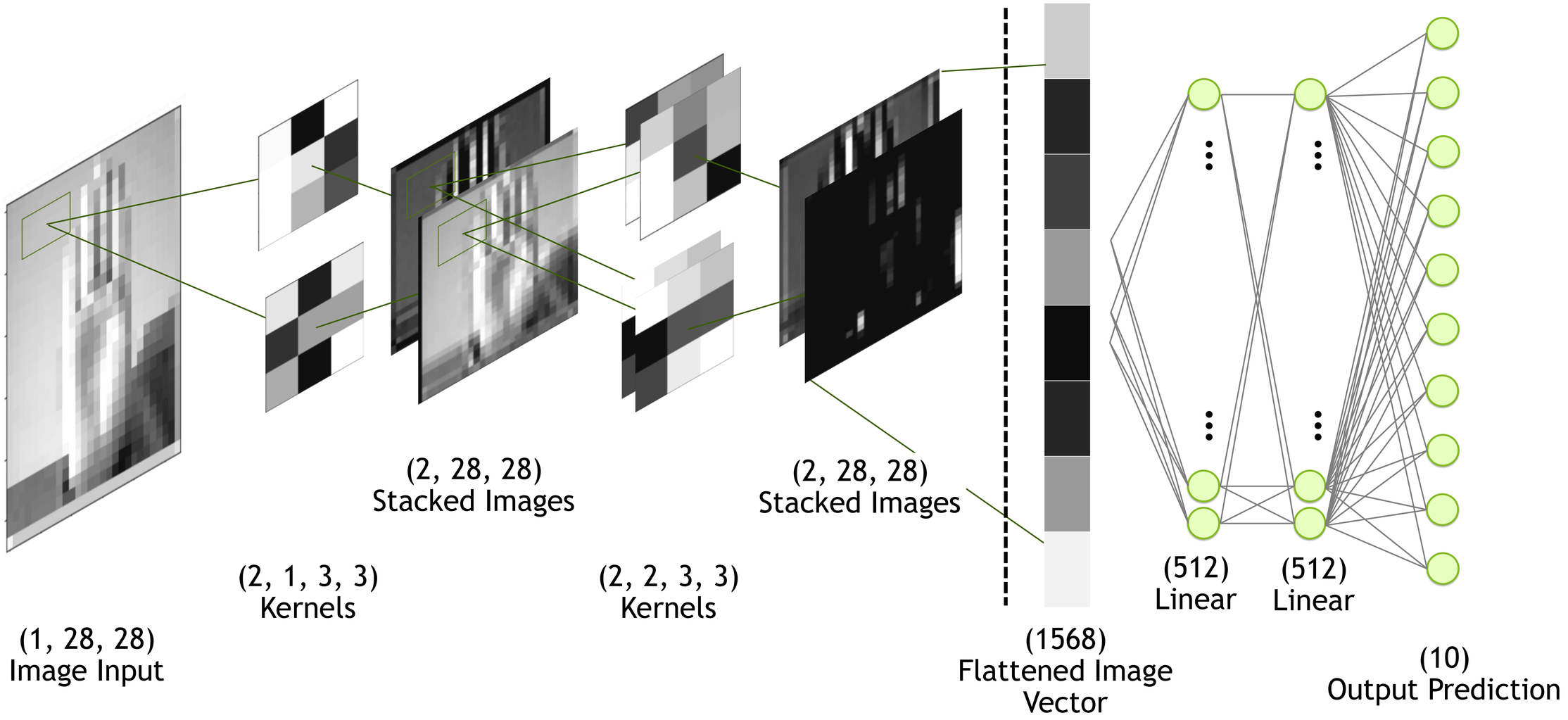
Kernel

w_1	w_2	w_3
w_4	w_5	w_6
w_7	w_8	w_9

Neuron

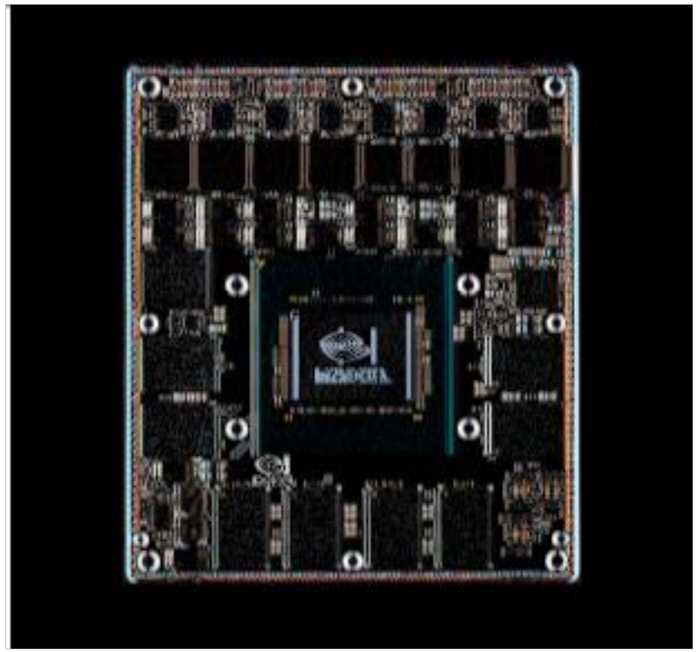


Kernels and Neural Networks



Finding Edges

Vertical Edges

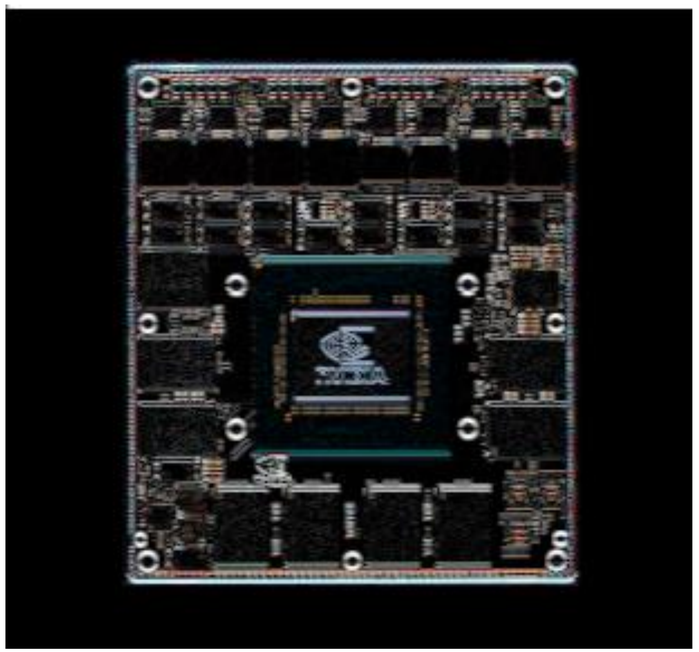


1	0	-1
2	0	-2
1	0	-1

Original Image

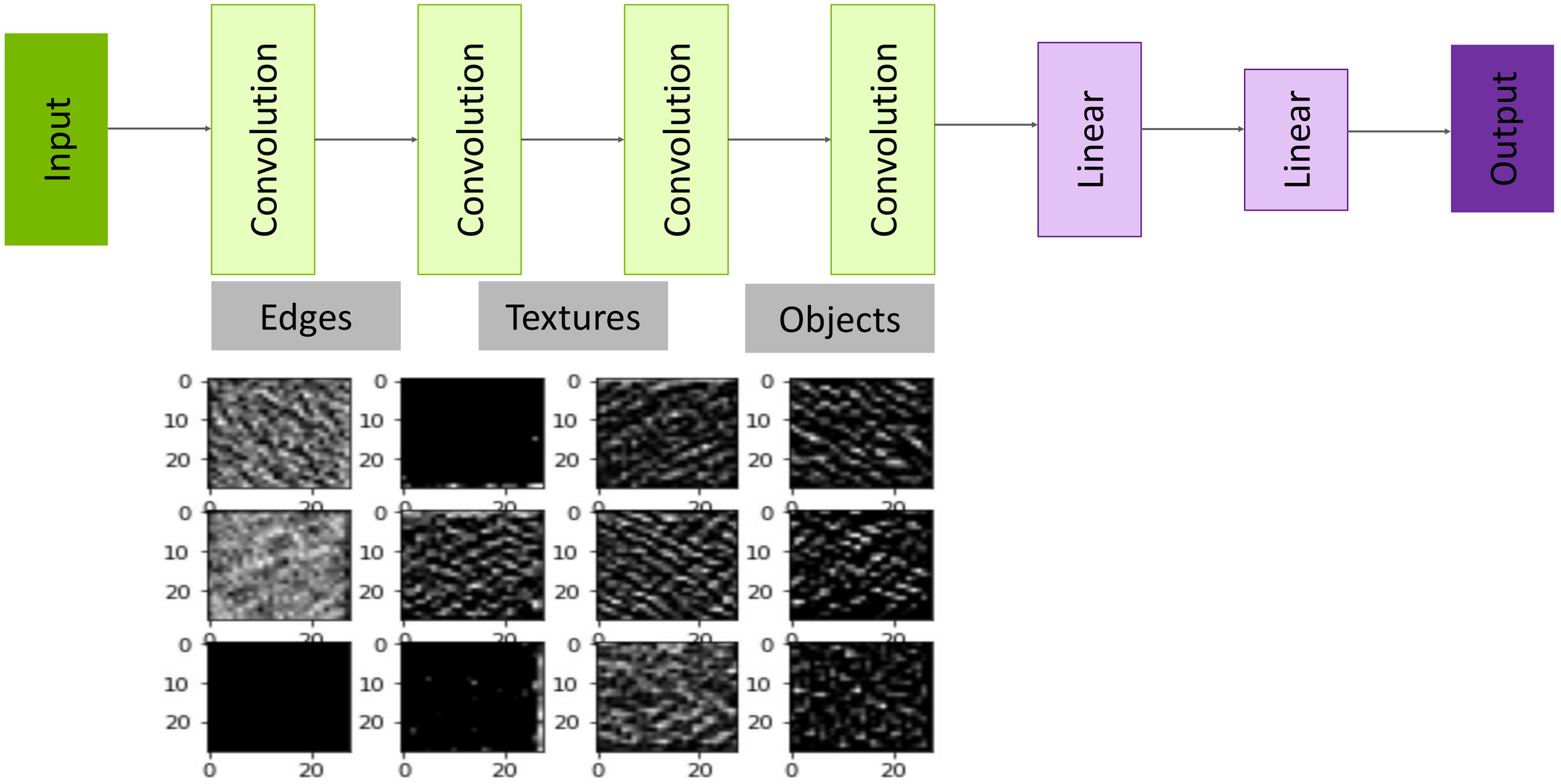
0	0	0
0	1	0
0	0	0

Horizontal Edges



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

Neural Network Perception

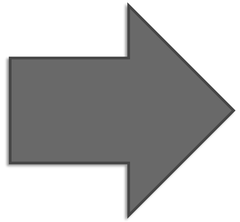


Neural Network Perception

Other Layers in the Model

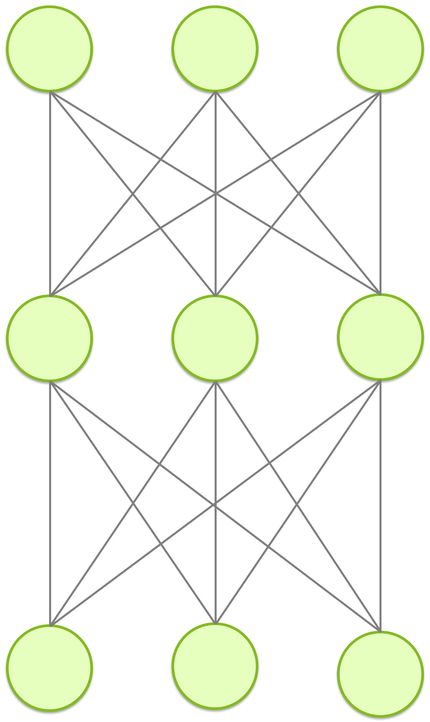
Max Pooling

110	256	153	67
12	89	88	43
10	15	50	55
23	9	49	23



256	153
23	55

Dropout



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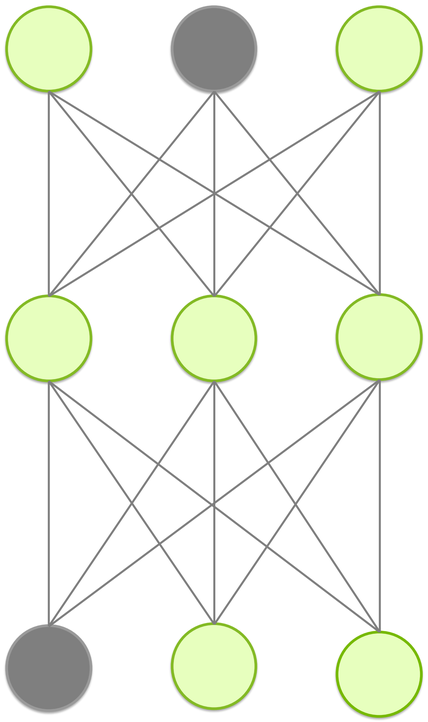

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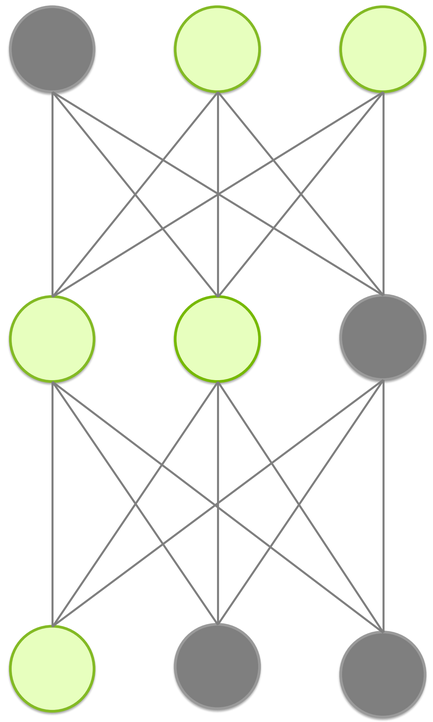

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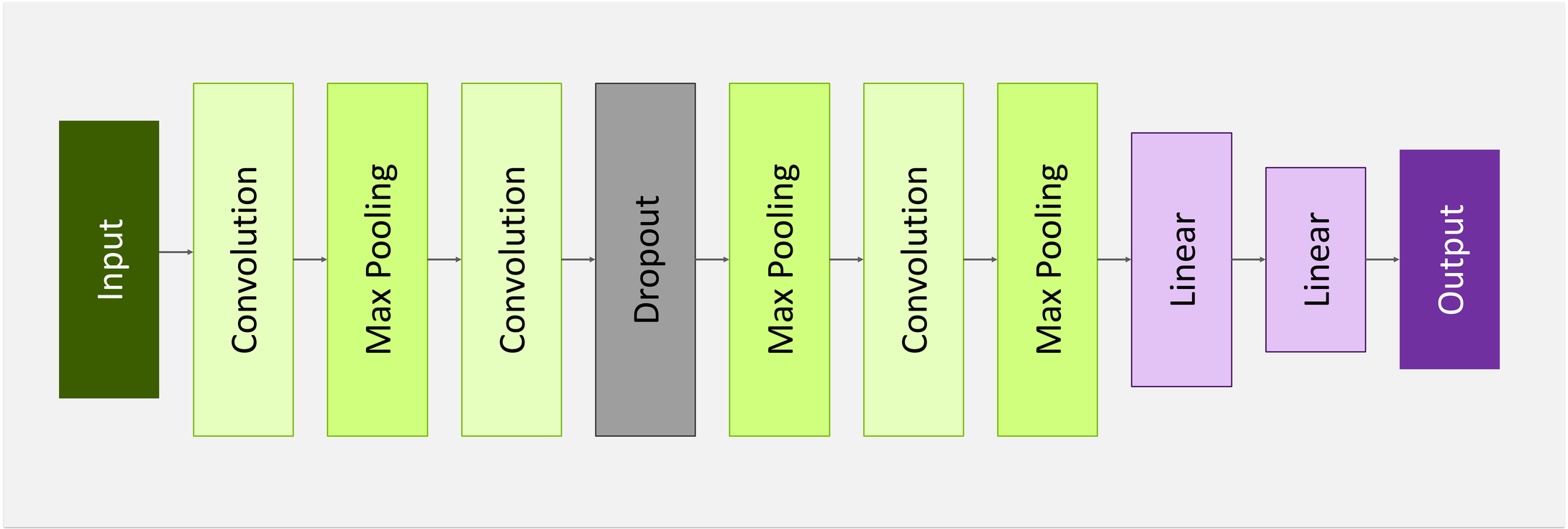
Whole Architecture



Let’s go!