COMPUTER VISION

CONVOLUTION ON IMAGES

AGENDA

This video lecture focuses on understanding:

- Why machine learning and simple neural networks are not best solution for extracting information out of images
- Concept of convolution
- How convolution helps to extract information our of images

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1. CONCEPT OF CONVOLUTION

CONVOLUTION = (10 X 0) + (20 X 0) + (30 X 1) + (0 X 0) + (10 X 1) + (20 X 0) + (20 X 1) + (80 X 0) + (200 X 0) = 60

10	20	30
0	10	20
20	80	200

X

0	0	1
0	1	0
1	0	0

=

60

INPUT MATRIX

Size = 3 X 3

FILTER MATRIX

Size = 3 X 3

CONVOLUTED MATRIX

Size = 1 X 1

1. CONCEPT OF CONVOLUTION

INPUT IMAGE

10	20	30	20	80	120	50	60	70	80
0	10	20	80	0	20	0	170	190	200
20	80	200	90	100	200	190	180	10	20
200	90	255	255	255	255	255	60	70	100
150	0	255	255	255	255	255	80	70	90
170	0	0	40	40	30	0	50	20	90
180	190	10	20	60	0	120	40	10	10
1	100	0	60	0	50	100	50	60	30
20	110	110	60	20	40	80	60	30	10
60	60	0	230	0	20	200	70	180	200

INPUT IMAGE in pixels matrix

Size = 10 x 10 pixels

Channels = 1 channel

1. CONCEPT OF CONVOLUTION

10	20	30	20	80	120	50	60	70	80
0	10	20	80	0	20	0	170	190	200
20	80	200	90	100	200	190	180	10	20
200	90	255	255	255	255	255	60	70	100
150	0	255	255	255	255	255	80	70	90
170	0	0	40	40	30	0	50	20	90
180	190	10	20	60	0	120	40	10	10
1	100	0	60	0	50	100	50	60	30
20	110	110	60	20	40	80	60	30	10
60	60	0	230	0	20	200	70	180	200

X

0	0	1
0	1	0
1	0	0

FILTER MATRIX

Size = 3 x 3 pixels

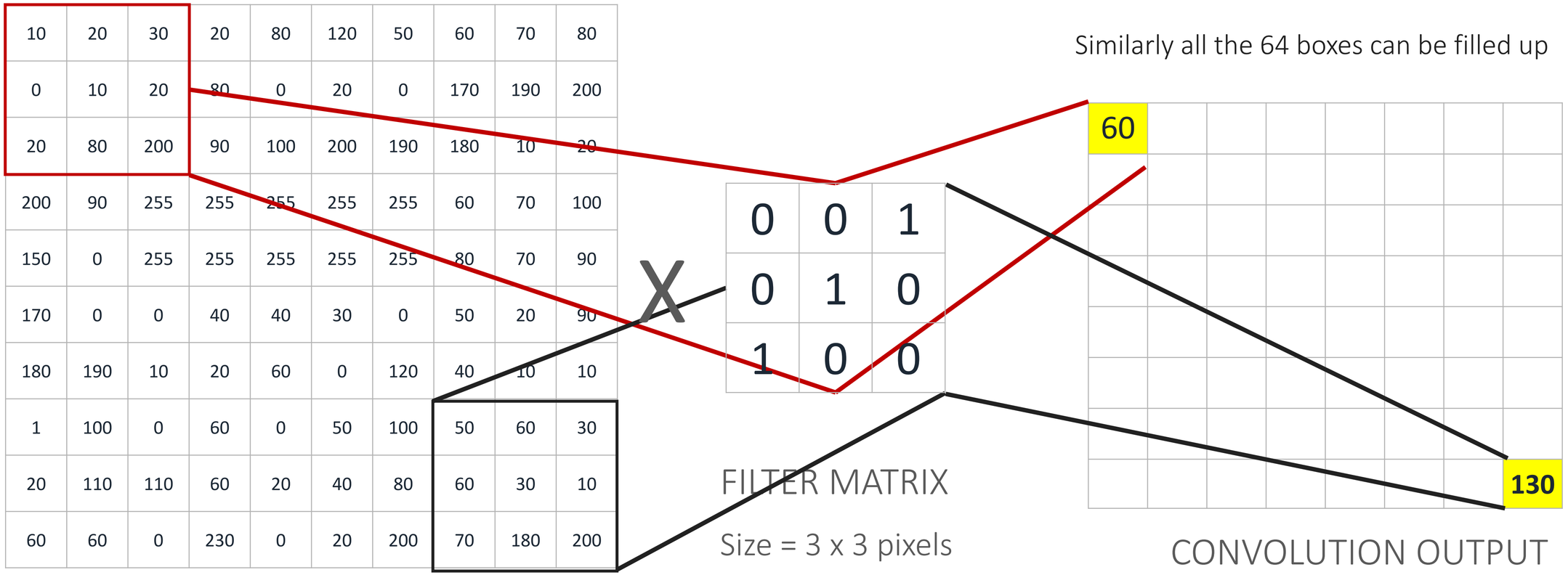
=

60

CONVOLUTED VALUE

Size = 1 X 1

1. CONCEPT OF CONVOLUTION



INPUT IMAGE in pixels matrix

Size = 10 x 10 pixels

Channels = 1 channel

FILTER MATRIX

Size = 3 x 3 pixels

CONVOLUTION OUTPUT

Size = 8 x 8 pixels

Channel = 1 channel

1. CONCEPT OF CONVOLUTION

10	20	30	20	80	120	50	60	70	80
0	10	20	80	0	20	0	170	190	200
20	80	200	90	100	200	190	180	10	20
200	90	255	255	255	255	255	60	70	100
150	0	255	255	255	255	255	80	70	90
170	0	0	40	40	30	0	50	20	90
180	190	10	20	60	0	120	40	10	10
1	100	0	60	0	50	100	50	60	30
20	110	110	60	20	40	80	60	30	10
60	60	0	230	0	20	200	70	180	200

INPUT IMAGE in pixels matrix

Size = 10 x 10 pixels

Channels = 1 channel

X

0	0	1
0	1	0
1	0	0

FILTER MATRIX

Size = 3 x 3 pixels

Similarly all the 64 boxes can be filled up

60	0	100	60	0	100	0	100
70	45	50	70	45	50	45	50
0	90	20	0	90	20	90	20
60	0	100	60	0	100	0	100
70	45	50	70	45	50	45	50
0	90	20	0	90	20	90	20
60	0	100	60	0	100	0	100
70	45	50	70	45	50	45	130

CONVOLUTION OUTPUT

Size = 8 x 8 pixels

Channel = 1 channel

1. CONCEPT OF CONVOLUTION

60	0	100	60	0	100	0	100
70	45	50	70	45	50	45	50
0	90	20	0	90	20	90	20
60	0	100	60	0	100	0	100
70	45	50	70	45	50	45	50
0	90	20	0	90	20	90	20
60	0	100	60	0	100	0	100
70	45	50	70	45	50	45	130

CONVOLUTION OUTPUT

Size = 8 x 8 pixels

Channel = 1 channel

0	0	1
0	1	0
1	0	0

X

10	20	30
0	10	20
20	80	200

IMAGE MATRIX

Size = 3 x 3 pixels

Channel = 1 channel

60 is a unique number that was obtained by combining some pixels from the image

FILTERS play a vital role in obtaining these unique features

CONVOLUTION helps to extract unique features/characteristics from an image

2. APPLICATION OF CONVOLUTION

NEURAL NETWORK CLASSIFIER

10	20	30	20	80	120	50	60	70	80
0	10	20	80	0	30	0	170	190	200
20	80	200	90	100	200	190	180	10	20
200	90	255	255	255	255	255	60	70	100
150	0	255	255	255	255	255	80	70	90
170	0	0	40	40	30	0	50	20	90
180	190	10	20	60	0	120	40	10	10
1	100	0	60	0	50	100	50	60	30
20	110	110	60	20	40	80	60	30	10
60	60	0	230	0	20	200	70	180	200

10	20	30	20	80	10	180	200

INPUT IMAGE

Size = 10 x 10 pixels

Channels = 1 channel

INPUT IMAGE in pixels matrix

Size = 10 x 10 pixels

Channels = 1 channel

INPUT IMAGE pixel matrix flattened

Size = 1 x 100 pixels

Channels = 1 channel

2. APPLICATION OF CONVOLUTION

NEURAL NETWORK CLASSIFIER

10	20	30	20	80	120	50	60	70	80
0	10	20	80	0	20	0	170	190	200
20	80	200	90	100	200	190	180	10	20
200	90	255	255	255	255	255	60	70	100
150	0	255	255	255	255	255	80	70	90
170	0	0	40	40	30	0	50	20	90
180	190	10	20	60	0	120	40	10	10
1	100	0	60	0	50	100	50	60	30
20	110	110	60	20	40	80	60	30	10
60	60	0	230	0	20	200	70	180	200

10	20	30	20	80	10	180	200

INPUT IMAGE

Size = 100 x 100 pixels

Channels = 1 channel

INPUT IMAGE in pixels matrix

Size = 100 x 100 pixels

Channels = 1 channel

INPUT IMAGE pixel matrix flattened

Size = 1 x 10000 pixels

Channels = 1 channel

2. APPLICATION OF CONVOLUTION

NEURAL NETWORK CLASSIFIER

180	200	- - -	10	20	30	20	80	10

INPUT IMAGE pixel matrix flattened

Size = 1 x 100 pixels

Channels = 1 channel

CONVOLUTED MATRIX

Size = 30 x 30 pixels

Channels = 1 channel

60	0	100	60
70	45	50	70
0	90	20	0
60	0	100	60
70	45	50	70
0	90	20	0
60	0	100	60
70	45	50	70

FILTER MATRIX

Size = 3 x 3 pixels

0	0	1
0	1	0
1	0	0

X

CONVOLUTED MATRIX

Size = 50 x 50 pixels

Channels = 1 channel

60	0	100	60
70	45	50	70
0	90	20	0
60	0	100	60
70	45	50	70
0	90	20	0
60	0	100	60
70	45	50	70

INPUT IMAGE

Size = 100 x 100 pixels

Channels = 1 channel

10	20	30	20	80	120	50	60	70	80
0	10	20	80	0	20	0	170	190	200
20	80	200	90	100	200	190	180	10	20
200	90	255	255	255	255	255	60	70	100
150	0	255	255	255	255	255	80	70	90
170	0	0	40	40	30	0	50	20	90
180	190	10	20	60	0	120	40	10	10
1	100	0	60	0	50	100	50	60	30
20	110	110	60	20	40	80	60	30	10
60	60	0	230	0	20	200	70	180	200

INPUT IMAGE in pixels

Size = 100 x 100 pixels

Channels = 1 channel

X

0	0	1
0	1	0
1	0	0

FILTER MATRIX

Size = 3 x 3 pixels

60	0	100	60	0	100
70	45	50	70	45	50
0	90	20	0	90	20
60	0	100	60	0	100
70	45	50	70	45	50
0	90	20	0	90	20
60	0	100	60	0	100
70	45	50	70	45	50

CONVOLUTED MATRIX

Size = 80 x 80 pixels

Channels = 1 channel

X

0	0	1
0	1	0
1	0	0

FILTER MATRIX

Size = 3 x 3 pixels

FEATURE EXTRACTION

INPUT IMAGE 1

255	255	255
255	0	0
255	0	0

X

1	0	1
0	1	0
1	0	1

→ 765

SQUARE SHAPE

INPUT IMAGE 2

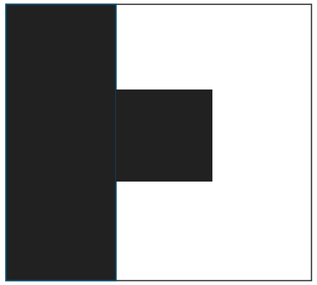
0	0	255
0	0	255
255	255	255

X

1	0	1
0	1	0
1	0	1

→ 765

SQUARE SHAPE



INPUT IMAGE 3

0	255	255
0	0	255
0	255	255

X

1	0	1
0	1	0
1	0	1

→ 510

NO SQUARE SHAPE

1

CONVOLUTION helps to extract unique features/characteristics from an image by producing a unique number as per the image pixels.

2

CONVOLUTION helps to reduce computation by reducing the dimension of the image which can be given as an input to simple neural networks to perform image classification.

SUMMARY

“FEATURE EXTRACTION”

Convolution helps to extract pixel features from the images and use the same as an input to a simple neural network classifier reducing the size of computation to perform image classification.

3. Python implementation

COMPUTER VISION

CONVOLUTION ON IMAGES