DEEPFLOW

CNN WORKSHOP

HELD BY YOUCEF OUHAB

DEEPFLOW

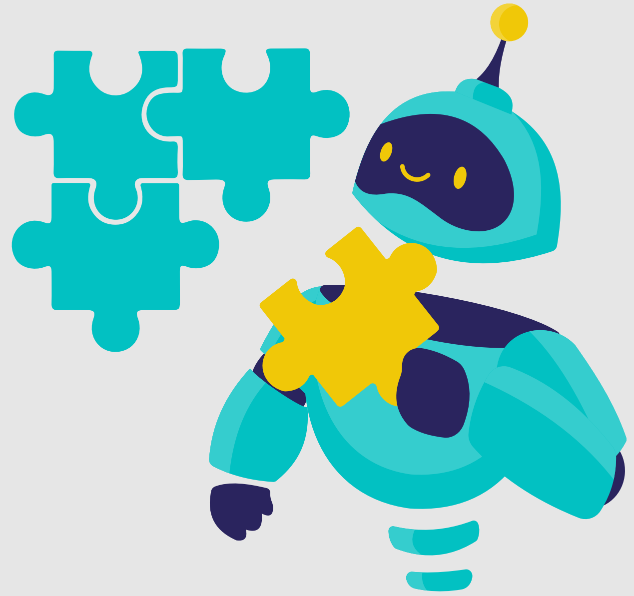
CONVOLUTIONAL NEURAL NETWORKS (CNNS):

A DEEP DIVE

DEEPFLOW

DEFINITION OF CNN

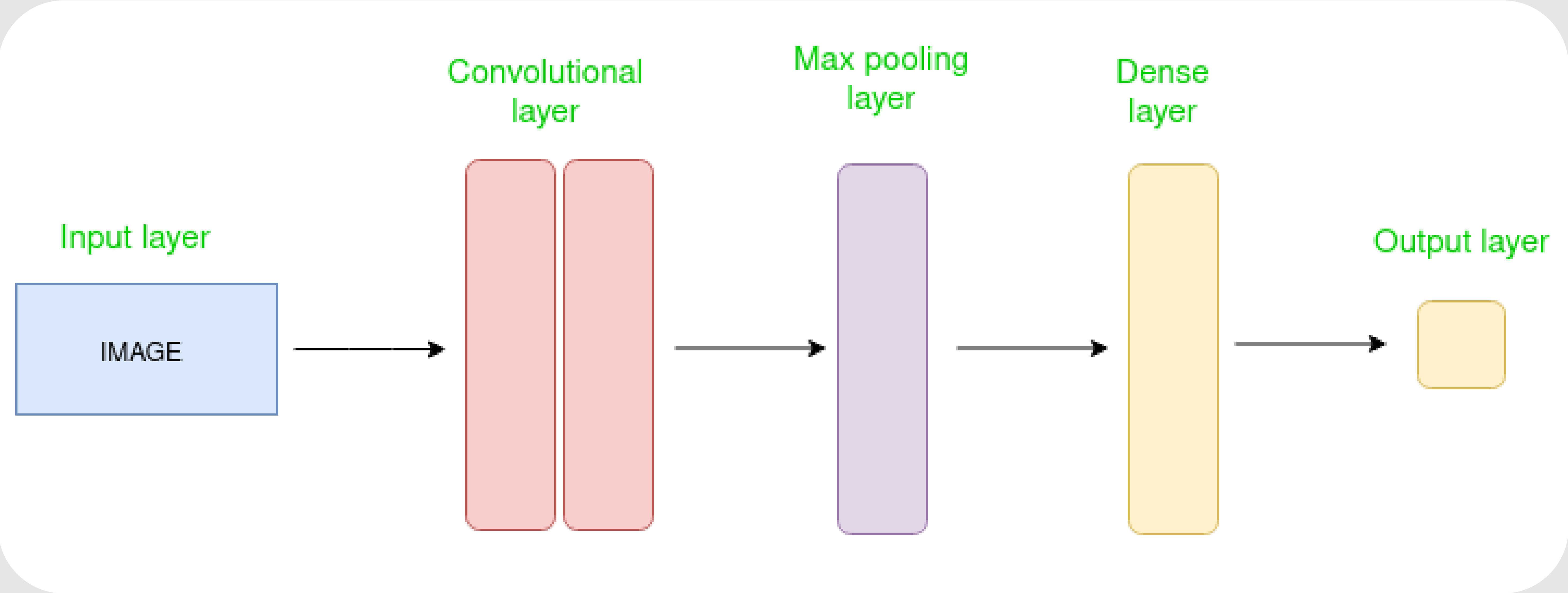
A CNN IS A TYPE OF DEEP LEARNING MODEL DESIGNED FOR PROCESSING STRUCTURED GRID DATA, SUCH AS IMAGES. IT AUTOMATICALLY AND ADAPTIVELY LEARNS SPATIAL HIERARCHIES OF FEATURES FROM INPUT IMAGES.



source:https://www.geeksforgeeks.org/introduction-convolution-neural-network/

DEFINITION OF CNN

DEEPFLOW

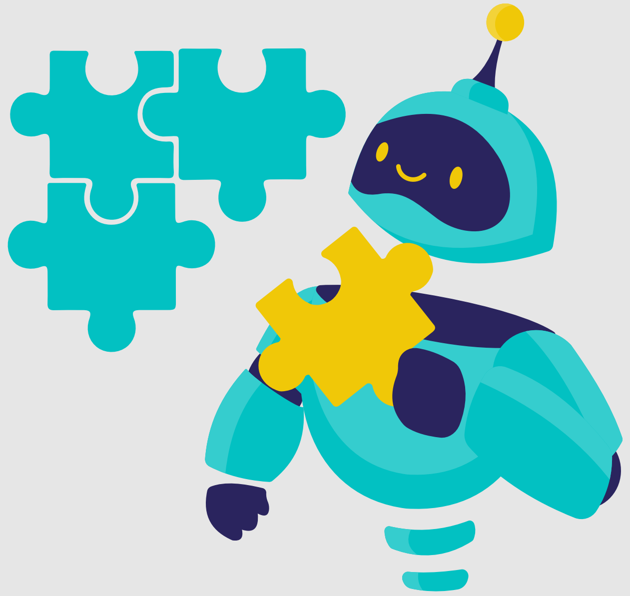


source:https://www.geeksforgeeks.org/introduction-convolution-neural-network/

DEFINITION OF CNN

DEEPFLOW

CNNS EXCEL IN TASKS INVOLVING IMAGE RECOGNITION AND PROCESSING DUE TO THEIR ABILITY TO CAPTURE SPATIAL FEATURES.



DEFINITION OF CNN

DEEPFLOW

THE ARCHITECTURE TYPICALLY INCLUDES:

- CONVOLUTIONAL LAYERS FOR FEATURE EXTRACTION
- POOLING LAYERS FOR DIMENSIONALITY REDUCTION
- FULLY CONNECTED (FC) LAYERS FOR CLASSIFICATION.

WHY CNNS?

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CNNS CAPTURE LOCAL PATTERNS IN INITIAL LAYERS AND MORE GLOBAL PATTERNS IN DEEPER LAYERS

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WHY CNNS?

THE DESIGN OF CNNS IS INFLUENCED BY THE HUMAN VISUAL SYSTEM, PARTICULARLY THE WAY NEURONS RESPOND TO OVERLAPPING REGIONS IN THE VISUAL FIELD.

WHY CNNS?

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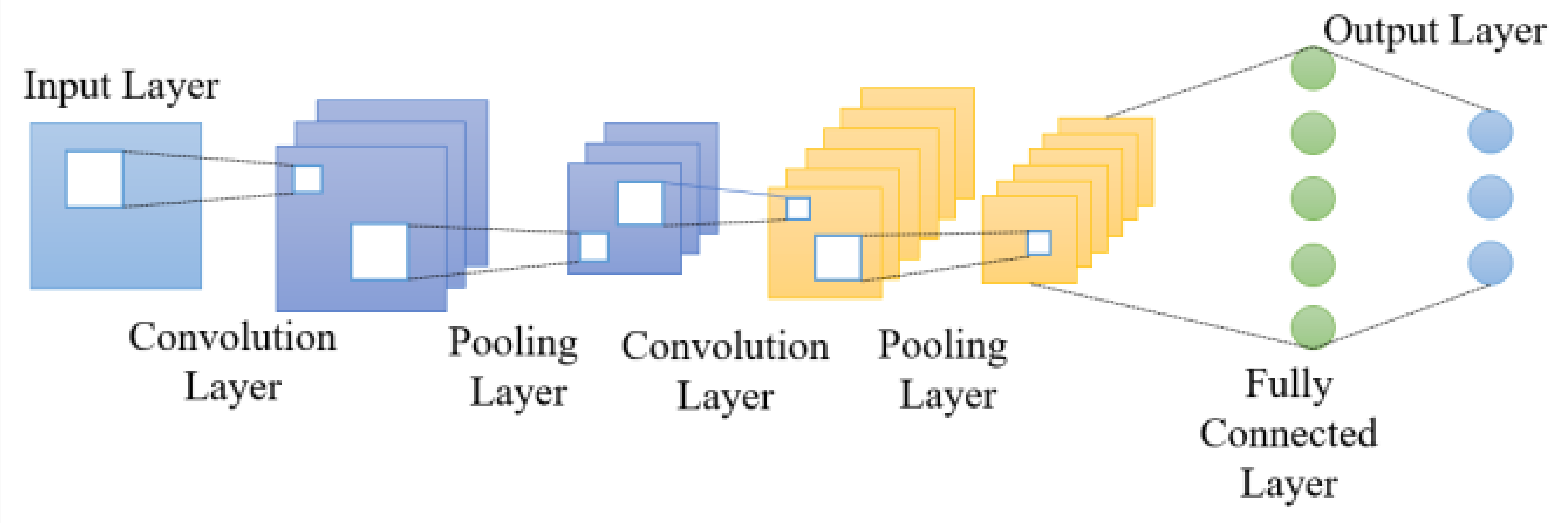
CNNS ARE WIDELY USED IN VARIOUS APPLICATIONS, INCLUDING MEDICAL IMAGE ANALYSIS, AUTONOMOUS VEHICLES, AND SURVEILLANCE SYSTEMS.

CNN ARCHITECTURE OVERVIEW

DEEPFLOW



CNN ARCHITECTURE OVERVIEW

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TYPICAL SEQUENCE IN A CNN WHERE THE INPUT IMAGE IS PROCESSED THROUGH CONVOLUTIONAL LAYERS (CONV), ACTIVATION FUNCTIONS LIKE RELU, POOLING LAYERS (POOL), FULLY CONNECTED LAYERS (FC), AND FINALLY PRODUCES AN OUTPUT.

INPUT LAYER

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INPUT FORMAT (RGB, GRAYSCALE):

IMAGES CAN BE IN COLOR (RGB) WITH THREE CHANNELS OR GRAYSCALE WITH A SINGLE CHANNEL.

SHAPE OF IMAGE DATA:

DEFINED BY DIMENSIONS (HEIGHT, WIDTH) AND THE NUMBER OF CHANNELS (DEPTH).

NORMALIZATION AND PREPROCESSING:

TECHNIQUES LIKE SCALING PIXEL VALUES TO A [0,1] RANGE TO IMPROVE TRAINING EFFICIENCY AND PERFORMANCE.

CONVOLUTIONAL LAYER

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WHAT IS A CONVOLUTION OPERATION?

- IN CONVOLUTIONAL NEURAL NETWORKS (CNNS), A CONVOLUTION OPERATION INVOLVES A SMALL MATRIX CALLED A FILTER OR KERNEL SLIDING OVER THE INPUT IMAGE TO PRODUCE A FEATURE MAP. THIS PROCESS HELPS IN DETECTING SPECIFIC FEATURES LIKE EDGES, TEXTURES, OR PATTERNS WITHIN THE IMAGE.

CONVOLUTIONAL LAYER

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FILTERS/KERNELS, STRIDE, PADDING:

- FILTERS ARE SMALL MATRICES THAT DETECT SPECIFIC FEATURES
- STRIDE DETERMINES THE MOVEMENT OF THE FILTER
- PADDING INVOLVES ADDING EXTRA PIXELS AROUND THE INPUT TO CONTROL OUTPUT DIMENSIONS.

CONVOLUTIONAL LAYER

DEEPFLOW

PADDING:

PADDING INVOLVES ADDING EXTRA PIXELS (USUALLY ZEROS) AROUND THE BORDER OF THE INPUT IMAGE. THIS HELPS IN CONTROLLING THE SPATIAL SIZE OF THE OUTPUT FEATURE MAP. COMMON TYPES INCLUDE:

- VALID PADDING: NO PADDING; THE OUTPUT FEATURE MAP IS SMALLER THAN THE INPUT.
- SAME PADDING: PADDING IS ADDED SO THAT THE OUTPUT FEATURE MAP HAS THE SAME DIMENSIONS AS THE INPUT.

🔍 EXAMPLE:

USING A 5X5 IMAGE AND A 3X3 FILTER:

- WITHOUT PADDING & STRIDE 1: OUTPUT IS 3X3.
- WITH SAME PADDING & STRIDE 1: OUTPUT REMAINS 5X5.RESEARCHGATE
- WITH SAME PADDING & STRIDE 2: OUTPUT REDUCES TO 3X3.

CONVOLUTIONAL LAYER

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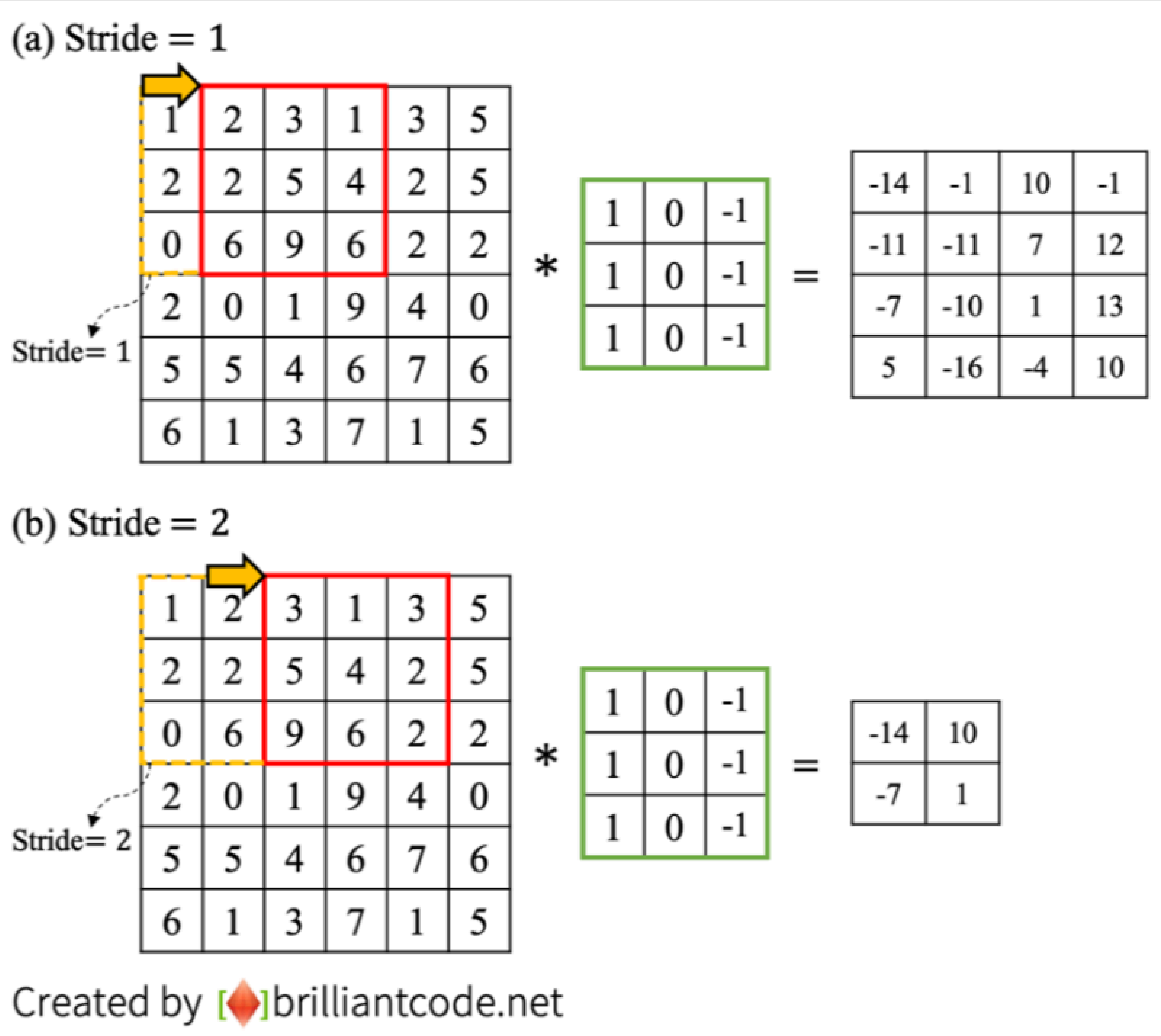

CONVOLUTIONAL LAYER

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

Input Image

$\otimes$

0	0	1
1	0	0
0	1	1

Feature Detector

=

0	1	0	0	0
0	1	1	1	0
1	0	1	2	1
1	4	2	1	0
0	0	1	2	1

Feature Map

CONVOLUTIONAL LAYER

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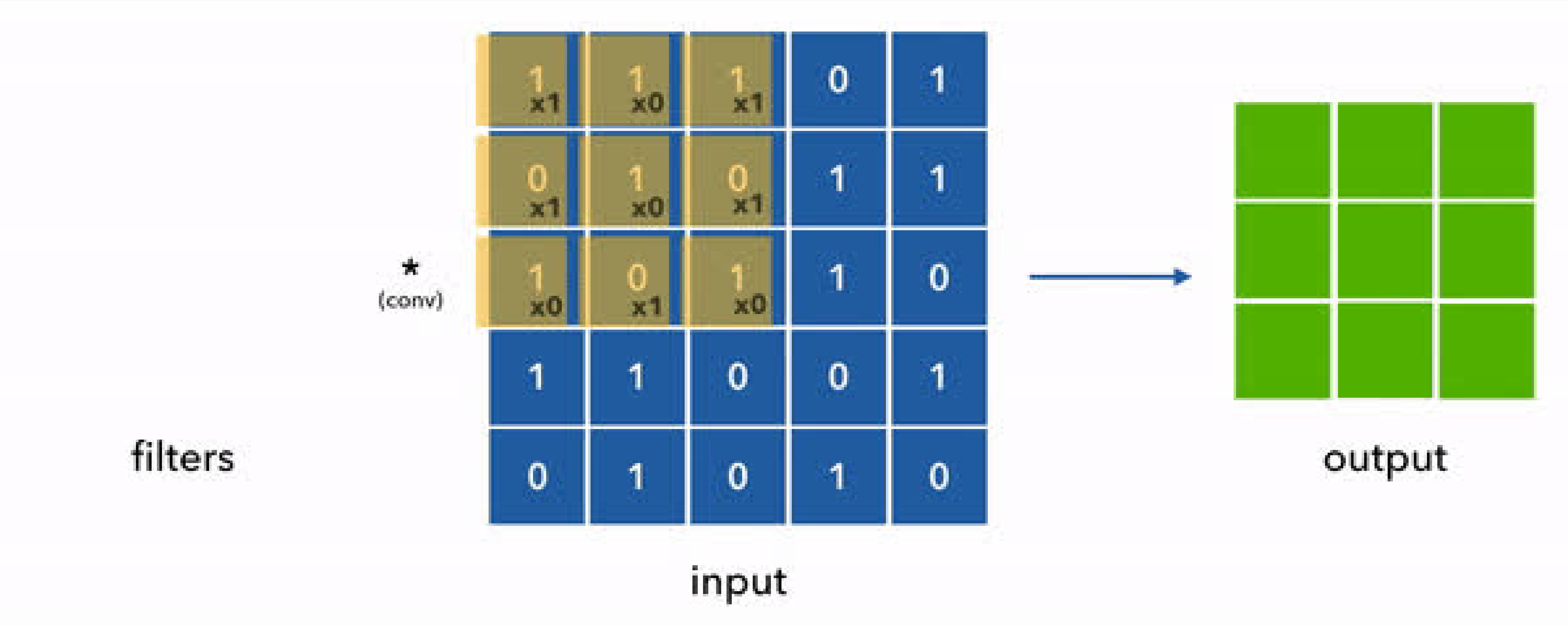

CONVOLUTIONAL LAYER

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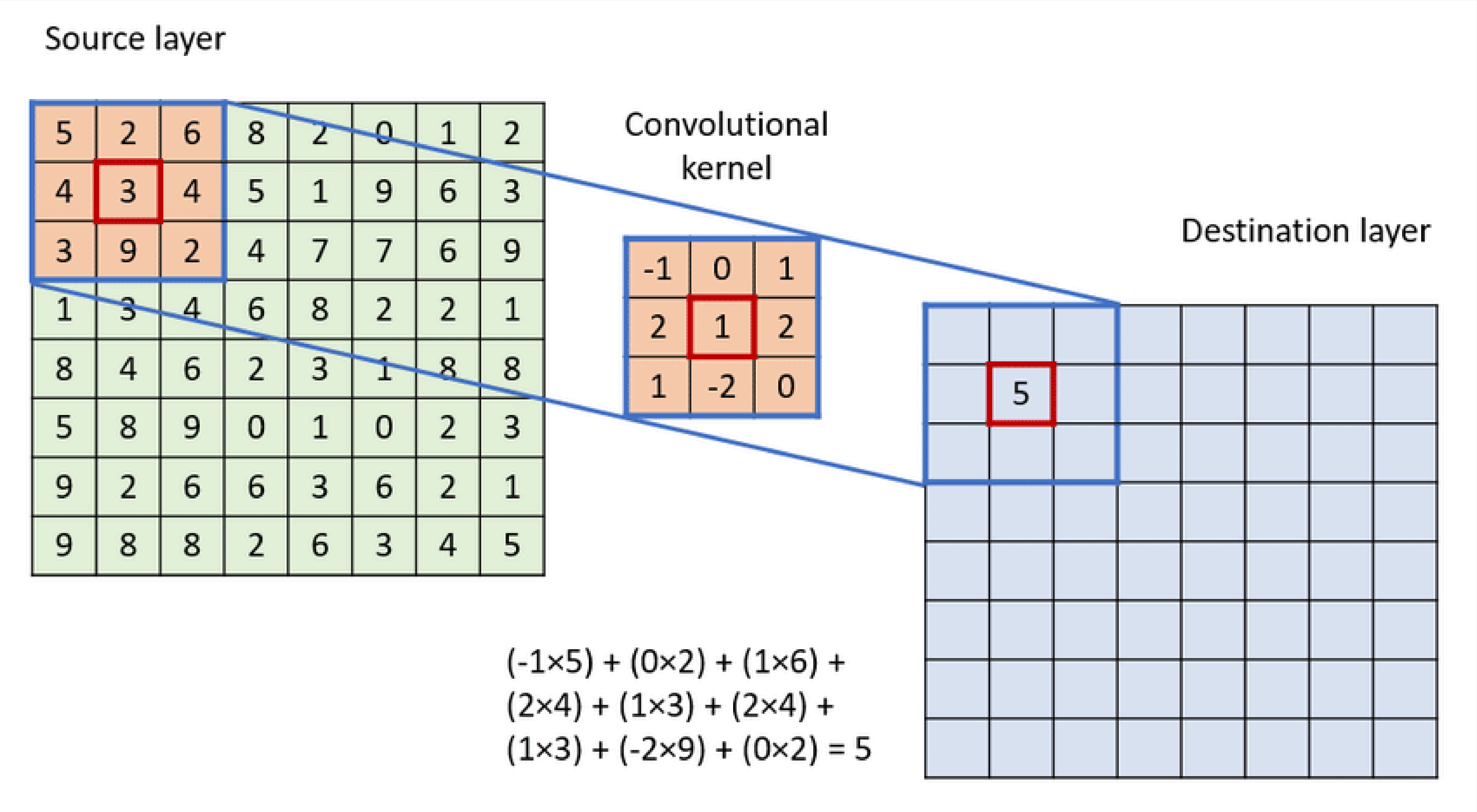

POOLING LAYER

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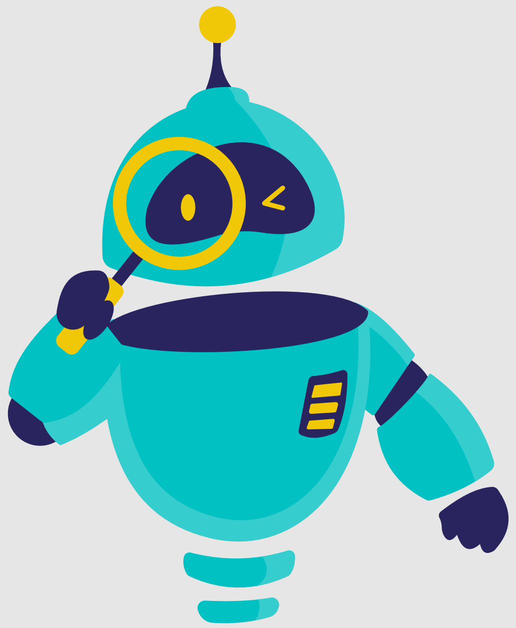
WHAT IS A POOLING LAYER?

A POOLING LAYER REDUCES THE SPATIAL SIZE (HEIGHT AND WIDTH) OF THE FEATURE MAPS WHILE RETAINING THE MOST IMPORTANT INFORMATION.



POOLING LAYER

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WHY IS POOLING USED?

TO REDUCE THE NUMBER OF PARAMETERS AND COMPUTATIONS IN THE NETWORK.

HELPS CONTROL OVERFITTING.

MAKES THE MODEL MORE ROBUST TO TRANSLATIONS AND DISTORTIONS.

TYPES OF POOLING:

MAX POOLING: TAKES THE MAXIMUM VALUE FROM A PATCH.

AVERAGE POOLING: TAKES THE AVERAGE OF THE VALUES IN A PATCH.

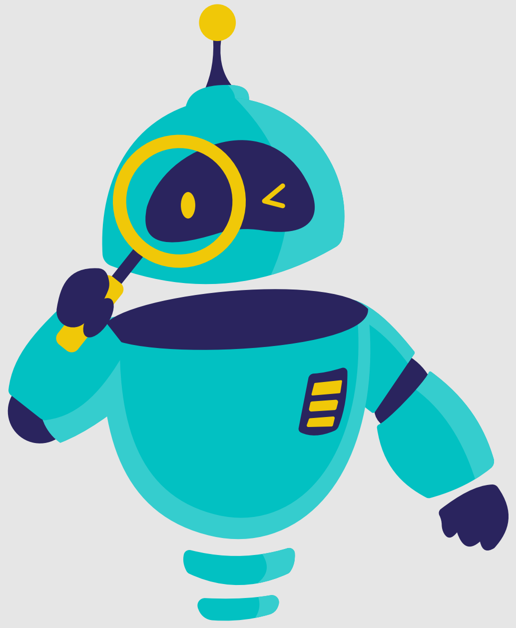
(MAX POOLING IS MOST COMMONLY USED.)

HOW IT WORKS:

A FILTER (E.G., 2X2) SLIDES OVER THE INPUT.

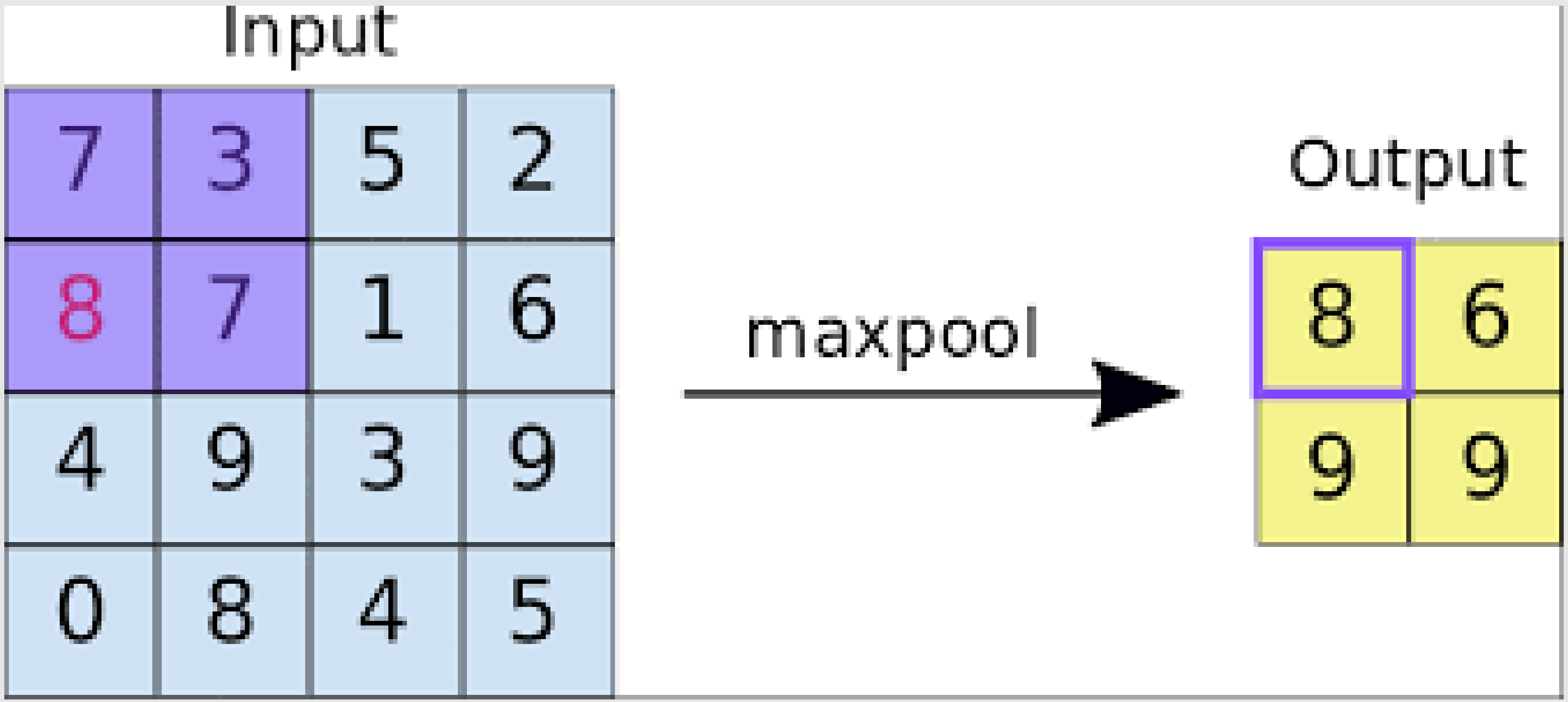
WITH STRIDE (USUALLY 2), IT MOVES STEP-BY-STEP.

IT OUTPUTS ONE VALUE PER PATCH.



POOLING LAYER

DEEPFLOW



ACTIVATION FUNCTIONS

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RELU AND ITS VARIANTS

THE RECTIFIED LINEAR UNIT (RELU) INTRODUCES NON-LINEARITY BY OUTPUTTING ZERO FOR NEGATIVE INPUTS AND THE INPUT ITSELF FOR POSITIVE INPUTS. VARIANTS INCLUDE LEAKY RELU AND PARAMETRIC RELU.

IMPORTANCE OF NON-LINEARITY

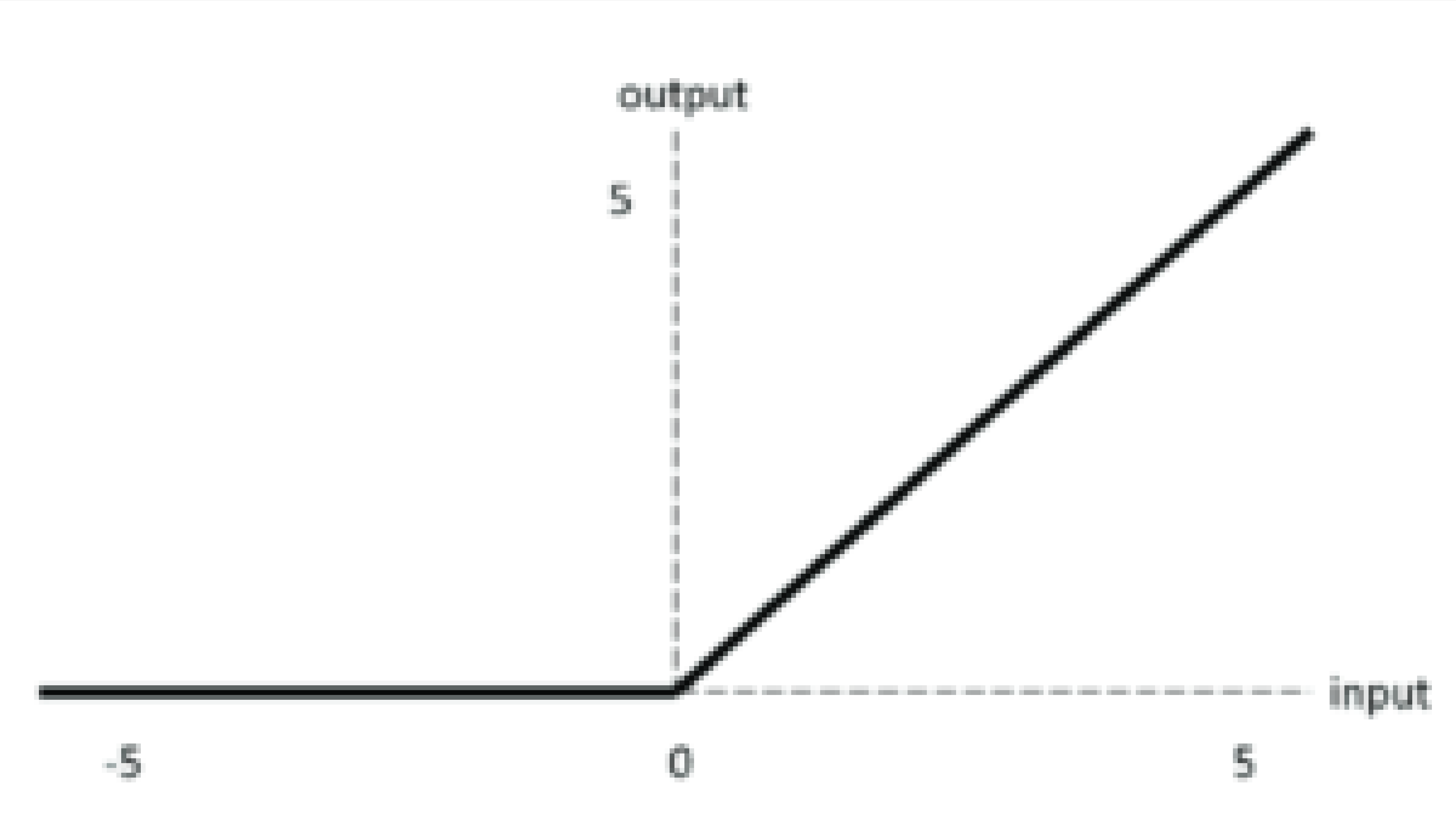
EXPLANATION: NON-LINEAR ACTIVATION FUNCTIONS ENABLE THE NETWORK TO LEARN COMPLEX PATTERNS BEYOND LINEAR RELATIONSHIPS.

SOURCE: RELU ACTIVATION FUNCTION IN DEEP LEARNING - GEEKSFORGEEKS

ACTIVATION FUNCTIONS

DEEPFLOW

RELU ACTIVATION FUNCTION



ACTIVATION FUNCTIONS

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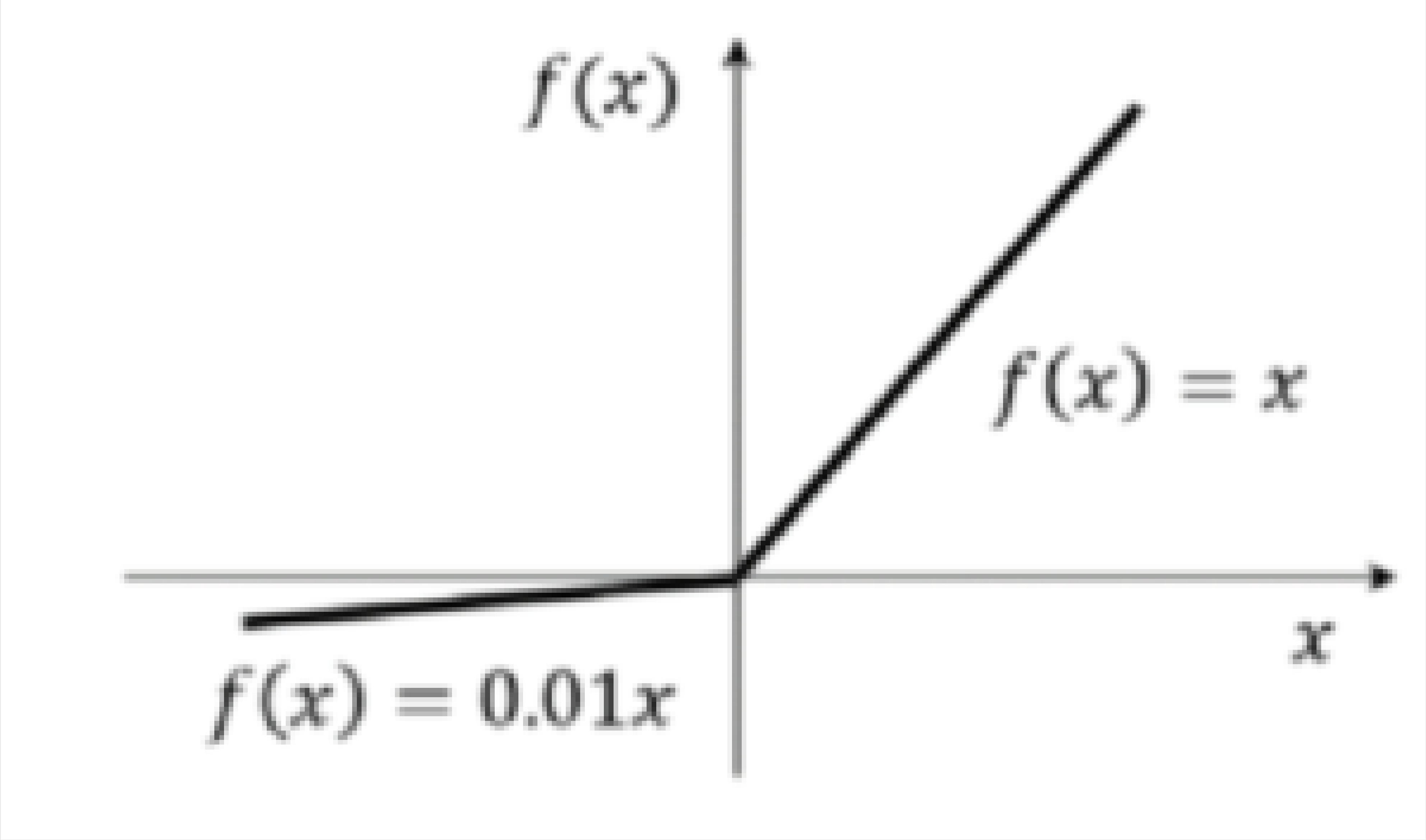
LEAKY RELU (LRELU)



ACTIVATION FUNCTIONS

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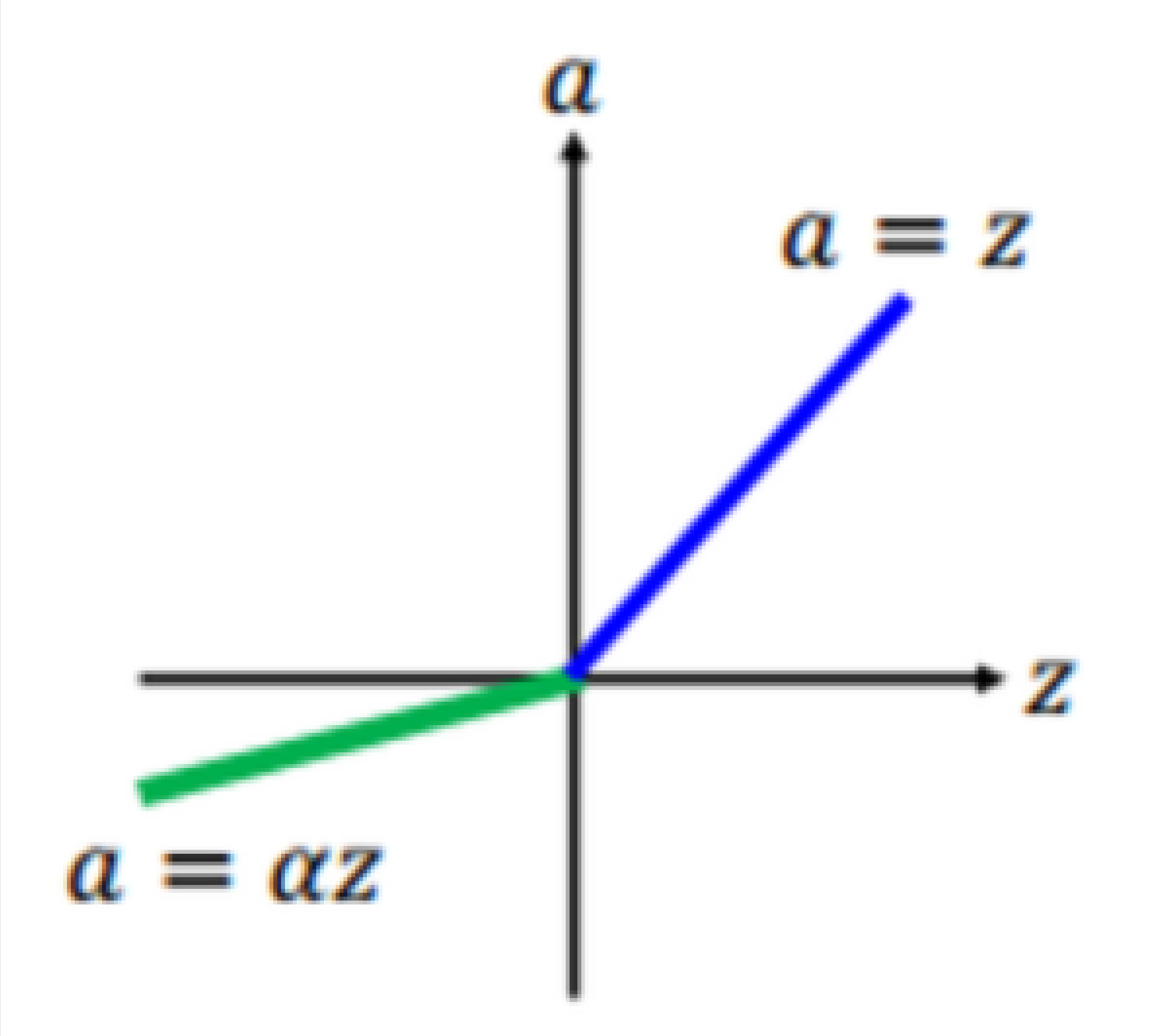
PARAMETRIC RELU (PRELU)



FLATTENING

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TRANSFORMING FEATURE MAPS TO 1D

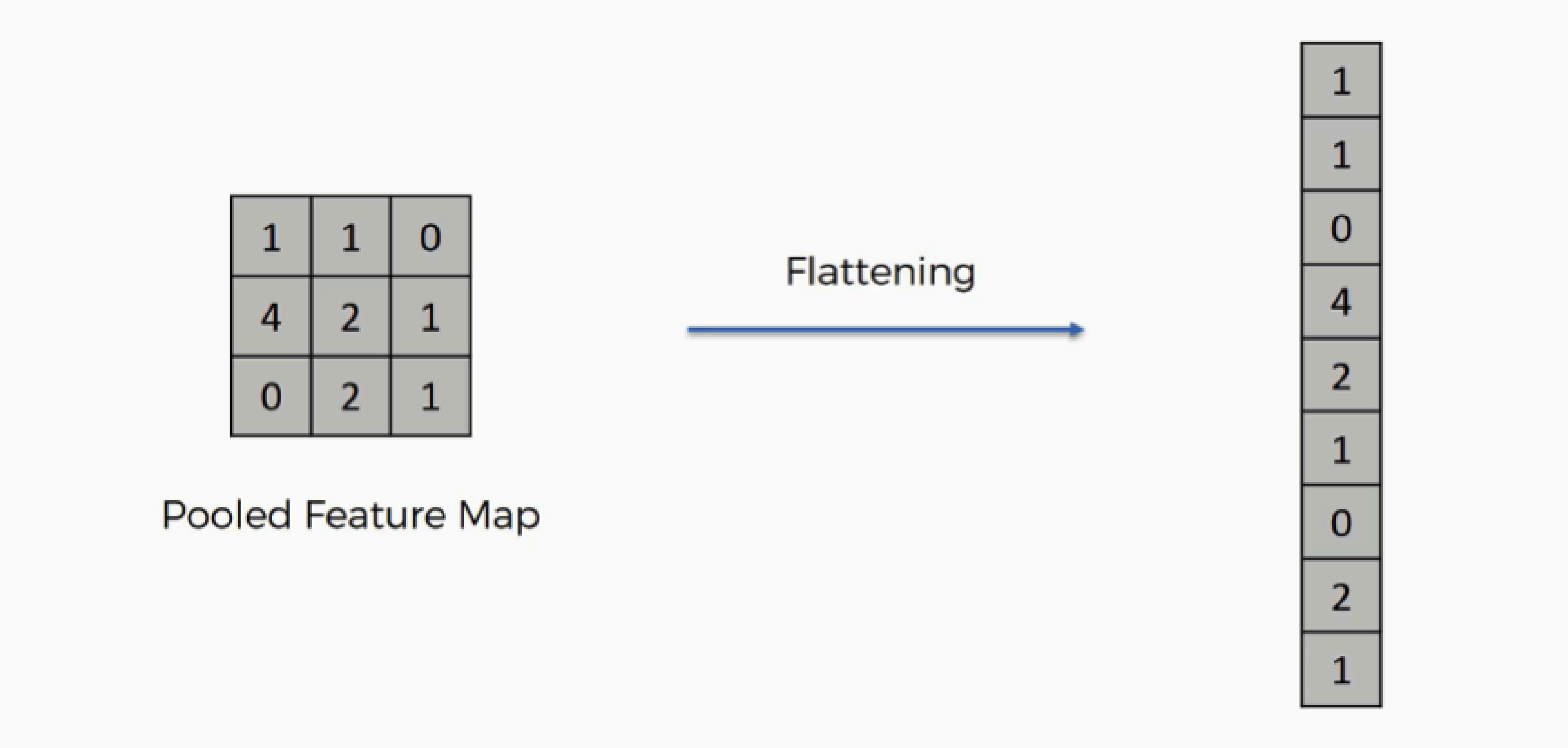
CONVERTS THE 2D MATRIX OF FEATURES INTO A 1D VECTOR TO FEED INTO FULLY CONNECTED LAYERS.

WHY IT'S NECESSARY BEFORE FC LAYERS?

FULLY CONNECTED LAYERS REQUIRE A 1D INPUT TO PERFORM CLASSIFICATION BASED ON THE EXTRACTED FEATURES.

FLATTENING

DEEPFLOW



FULLY CONNECTED LAYERS

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- **CONNECTING LEARNED FEATURES TO OUTPUT**

THESE LAYERS TAKE THE FLATTENED FEATURE VECTOR AND MAP IT TO THE DESIRED OUTPUT CLASSES.

- **IMPORTANCE OF DENSE LAYERS**

DENSE LAYERS COMBINE FEATURES TO MAKE FINAL PREDICTIONS, ACTING AS THE DECISION-MAKING COMPONENT OF THE NETWORK.

KEY HYPERPARAMETERS IN CNNS

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LEARNING RATE

CONTROLS HOW FAST THE MODEL LEARNS. TOO HIGH = UNSTABLE, TOO LOW = SLOW.

EPOCHS

NUMBER OF COMPLETE PASSES THROUGH THE TRAINING DATASET.

BATCH SIZE

NUMBER OF SAMPLES PROCESSED BEFORE MODEL WEIGHTS ARE UPDATED.

KERNEL SIZE

SIZE OF THE CONVOLUTION FILTER (E.G., 3×3, 5×5).

KEY HYPERPARAMETERS IN CNNS

DEEPFLOW

STRIDE

HOW FAR THE FILTER MOVES DURING CONVOLUTION.

PADDING

CONTROLS SPATIAL SIZE OF OUTPUT (E.G., SAME VS VALID).

NUMBER OF FILTERS

DETERMINES HOW MANY FEATURES ARE DETECTED AT EACH LAYER.

DROPOUT RATE

PREVENTS OVERFITTING BY RANDOMLY DISABLING NEURONS DURING TRAINING.

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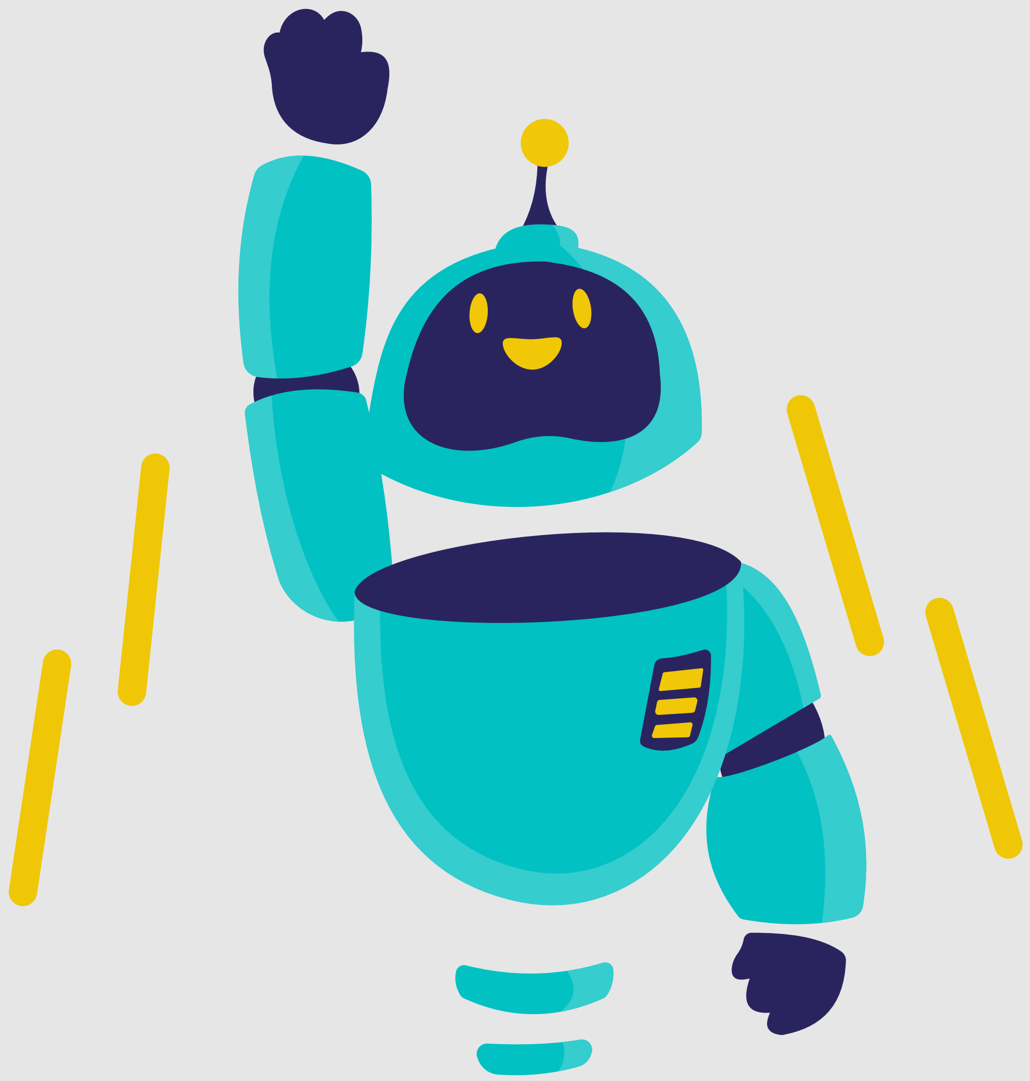
BASICALLY THAT’S IT 😅



DEEPFLOW

THANK YOU

SAY “YOUCEF YOU NAILED IT :)”