Deep Learning

- Deep learning is a class of machine learning algorithms that uses multiple layers to progressively extract higher level features from the raw input.
- For example, in image processing, lower layers may identify edges, while higher layers may identify the concepts relevant to a human such as digits or letters or faces.
- Deep learning is a subset of machine learning, which is essentially a neural network with three or more layers.
- These neural networks attempt to simulate the behavior of the human brain, allowing it to “learn” from large amounts of data.
- While a neural network with a single layer can still make approximate predictions, additional hidden layers can help to optimize and refine for accuracy.

Why Deep Learning?

- The different types of neural networks in deep learning, such as convolutional neural networks (CNN), recurrent neural networks (RNN), artificial neural networks (ANN), etc. are changing the way we interact with the world.
- These different types of neural networks are at the core of the deep learning revolution, powering applications like unmanned aerial vehicles, self-driving cars, speech recognition, etc.

can't machine learning algorithms do the same?

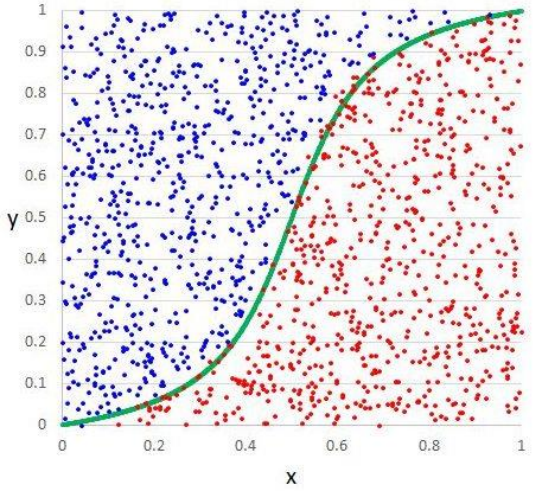
- Well, here are two key reasons why researchers and experts tend to prefer Deep Learning over Machine Learning:

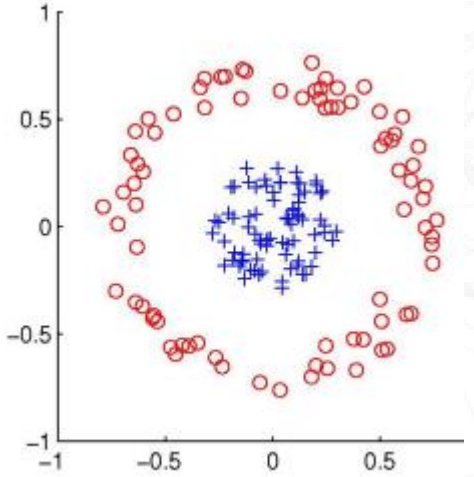
01. Decision Boundary

02. Feature Engineering

Curious? Let me explain-

01. Machine Learning vs. Deep Learning: Decision Boundary





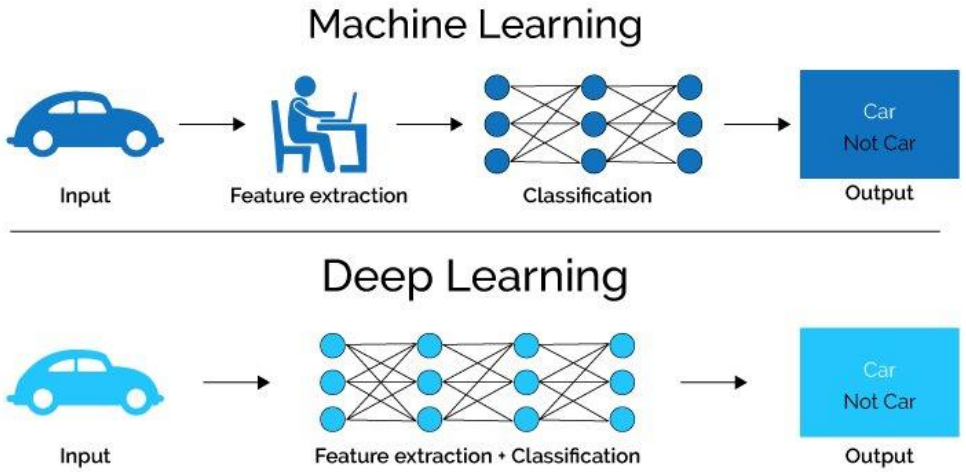
- Every Machine Learning algorithm is not capable of learning all the functions.
- This limits the problems these algorithms can solve that involve a complex relationship.

02. Machine Learning vs. Deep Learning: Feature Engineering

Feature Engineering
- Feature Extraction
- Feature Selection

- In feature extraction, we extract all the required features for our problem statement and,
- In feature selection, we select the important features that improve the performance of our machine learning or deep learning model.

Consider an image classification problem. Extracting features manually from an image needs strong knowledge of the subject as well as the domain. It is an extremely time-consuming process. Thanks to Deep Learning, we can automate the process of Feature Engineering!



Different types of Neural Networks in Deep Learning

Three important types of neural networks that form the basis for most pre-trained models in deep learning:

- Artificial Neural Networks (ANN)
- Convolution Neural Networks (CNN)
- Recurrent Neural Networks (RNN

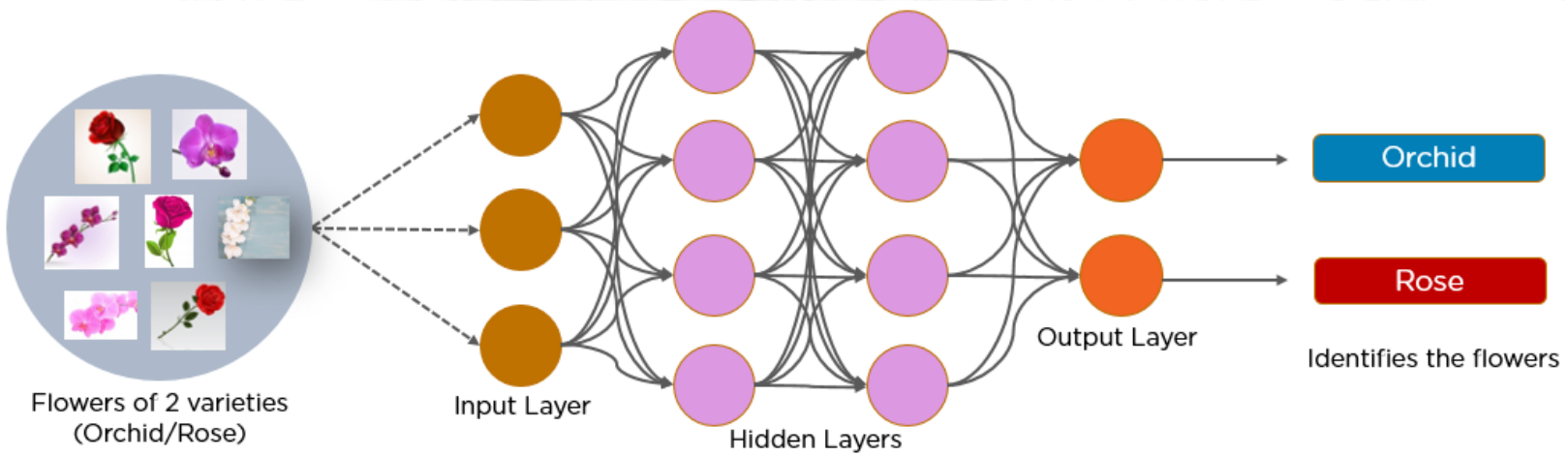
In this course, we will focus on Convolutional Neural Network

Convolutional Neural Network(CNN)

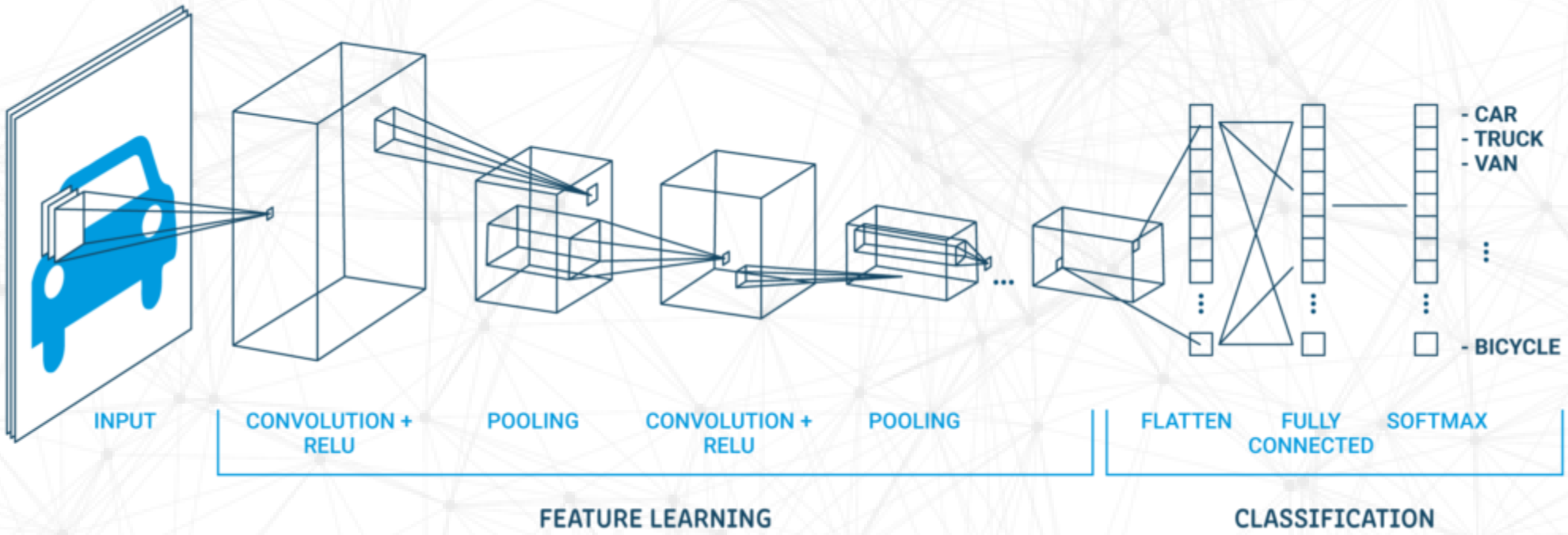
Convolutional neural networks are distinguished from other neural networks by their superior performance with image, speech, or audio signal inputs.

They have three main types of layers, which are:

- Convolutional layer
- Pooling layer
- Fully-connected (FC) layer

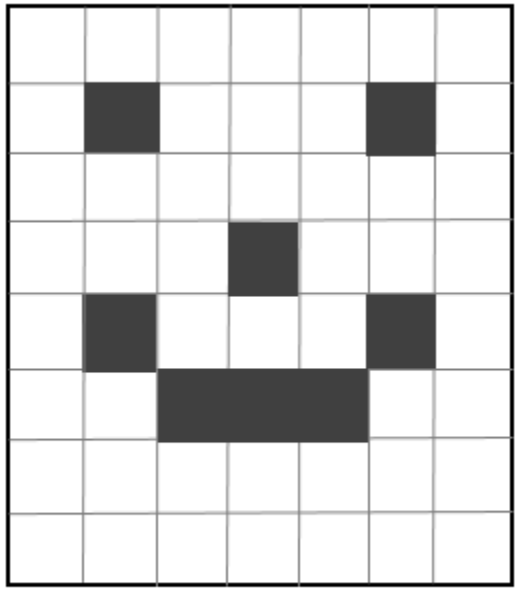


Convolutional Neural Network(CNN)



Convolutional Neural Network(CNN)

Real Image



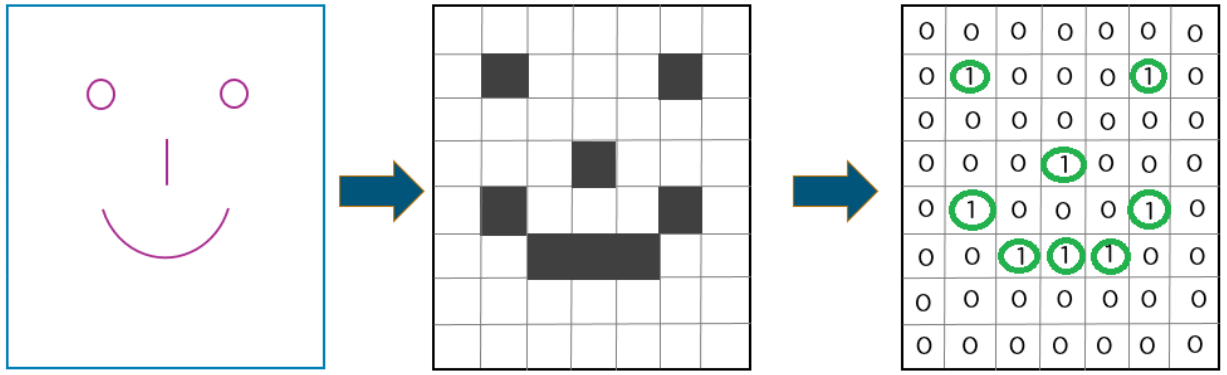
Represented in the form of black and white pixels

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
0	0	0	0	0	0	0

Image represented in the form of a matrix of numbers

Convolutional Neural Network(CNN)

- It is seen that, there is a lot of wasted spaces in each images.
- While there are only 784 pixels, it will be interesting to see if there was a way that we could condense the image down to the important features that distinguish what makes it a shoe, or pant or a shirt. That's where convolutions come in.



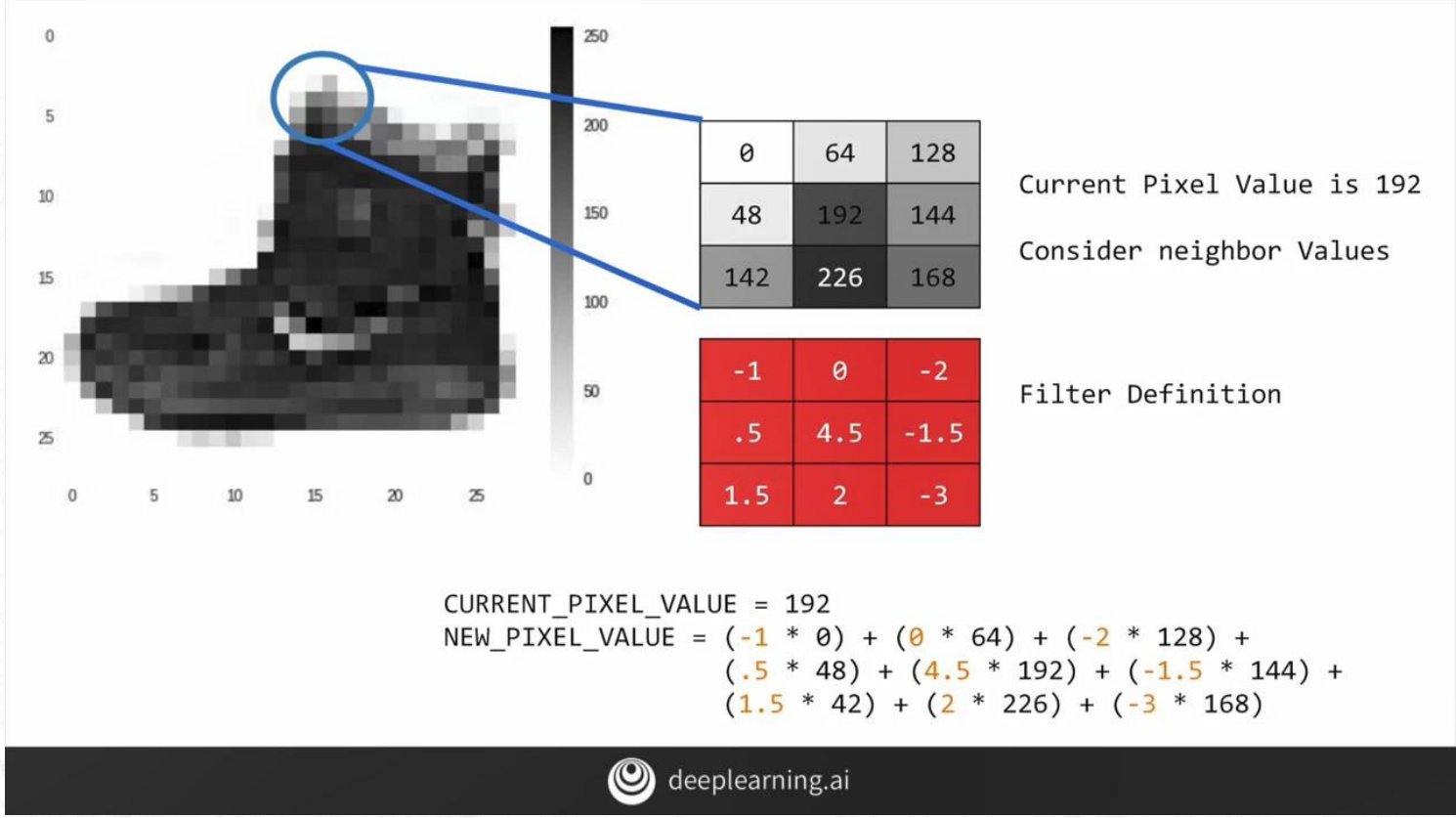
Real Image

Represented in the form of black and white pixels

Image represented in the form of a matrix of numbers

Convolutional Neural Network(CNN)

- In convolution, it usually involves having a filter and passing that filter over the image in order to change the underlying image(compressing).
- For every pixel, take its value and take a look at the value of its neighbors.
- If our filter is 3×3, then we can take a look at the immediate neighbor so that you have a corresponding 3×3 grid.
- Then to get the new value for the pixel, we simply multiply each neighbors by the corresponding value in the filter.
- That's a Convolution!



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

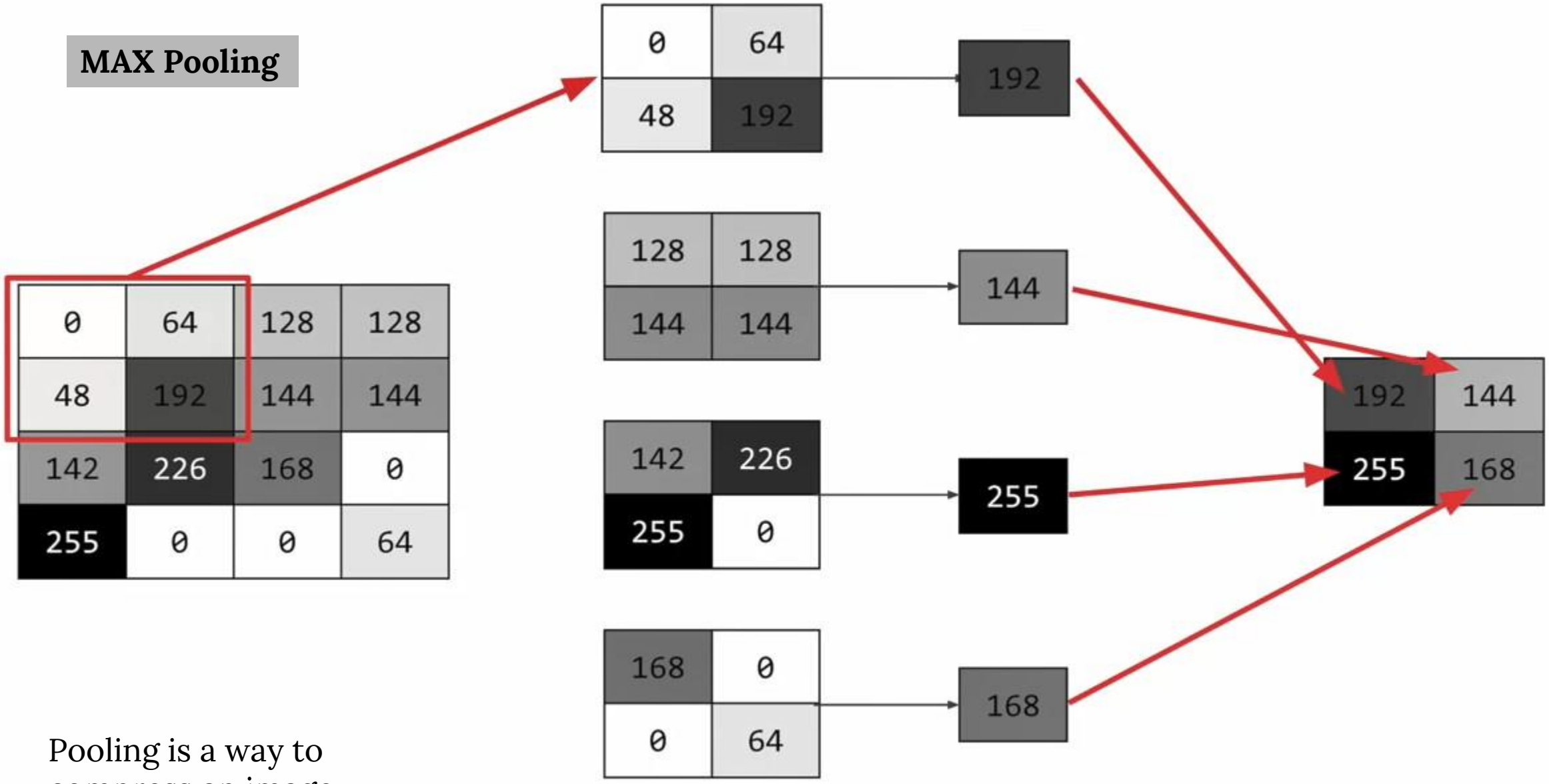
3×3 kernal

Before Convolution

After Convolution

- The idea is that some convolution will change the image in such a way that certain features in the image get emphasized.
- That's a very basic introduction to what convolutions do.
- But when it combines with something called 'Pooling', It can become really powerful.

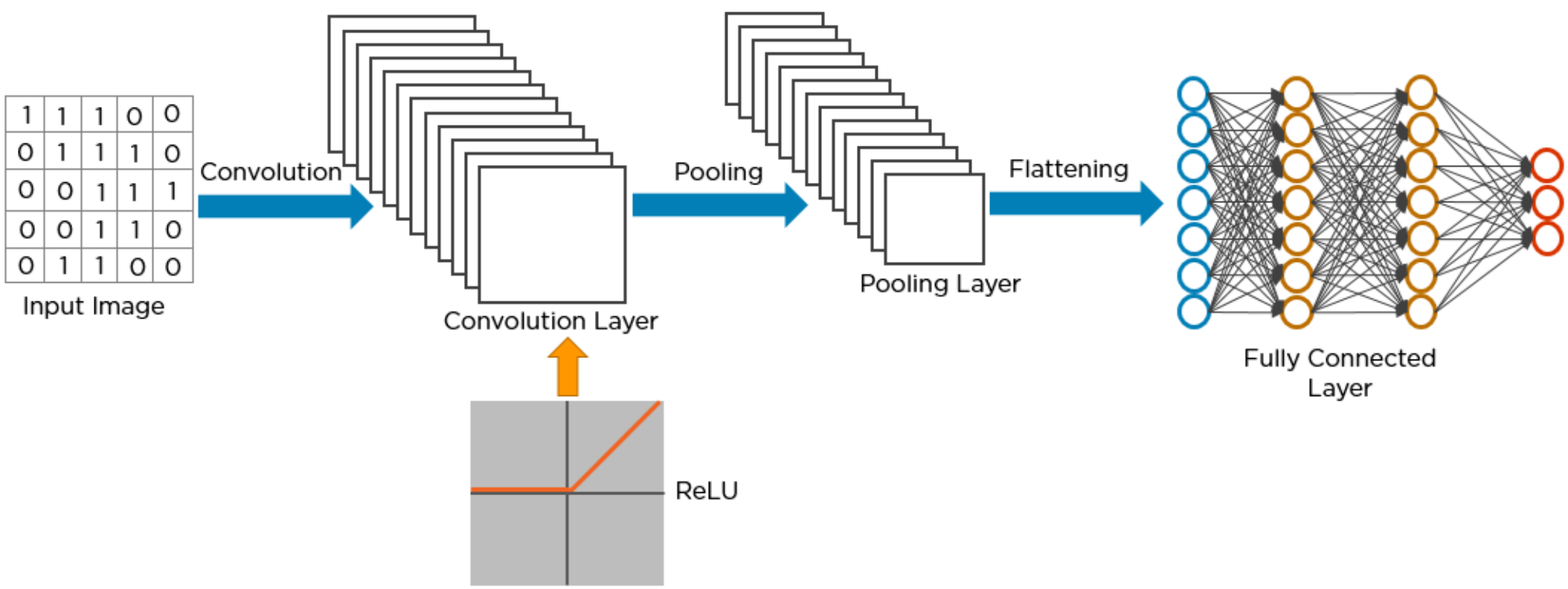
MAX Pooling



Pooling is a way to compress an image.

Convolutional Neural Network(CNN)

Flatten layers allow you to change the shape of the data from a vector of 2d matrixes (or nd matrices really) into the correct format for a dense layer to interpret. It's simply allowing the data to be operable by this different layer type.



Convolutional Neural Network(CNN)

How exactly CNN recognizes a bird:

- The pixels from the image are fed to the convolutional layer that performs the convolution operation
- It results in a convolved map
- The convolved map is applied to a ReLU function to generate a rectified feature map
- The image is processed with multiple convolutions and ReLU layers for locating the features
- Different pooling layers with various filters are used to identify specific parts of the image
- The pooled feature map is flattened and fed to a fully connected layer to get the final output