

California State University, Dominguez Hills

Department of Computer Science

CSC 595

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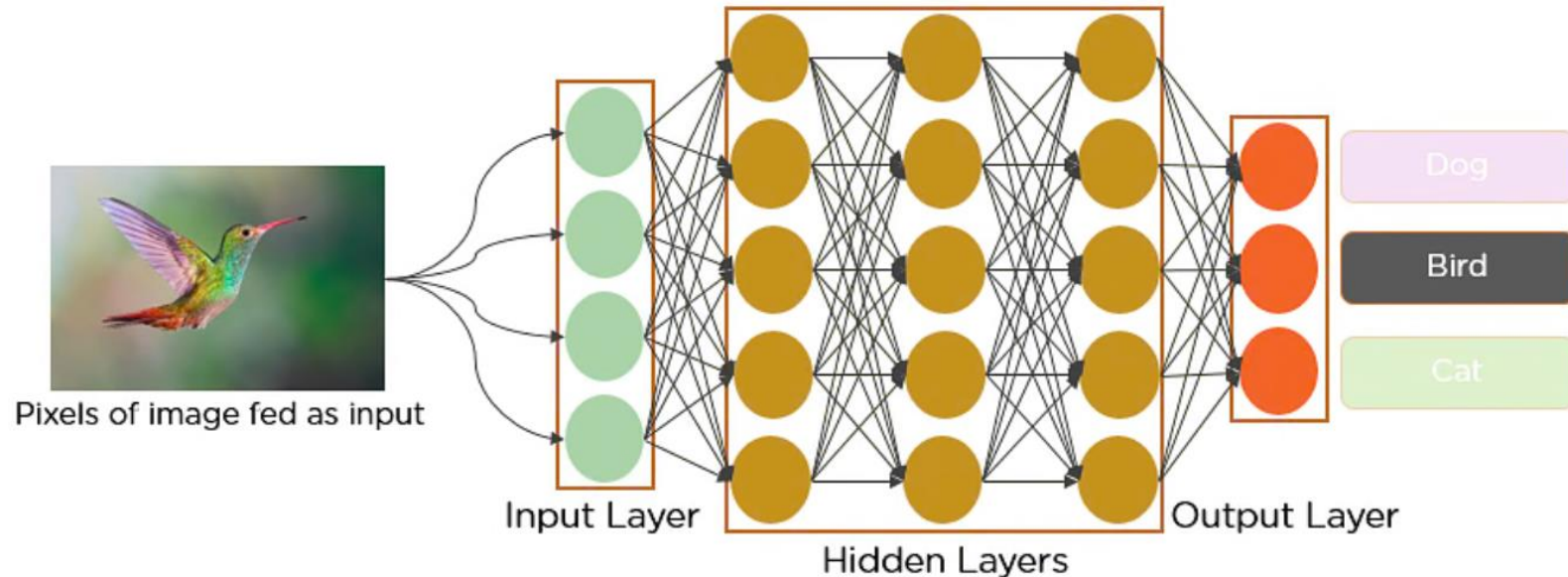
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Introduction to CNN

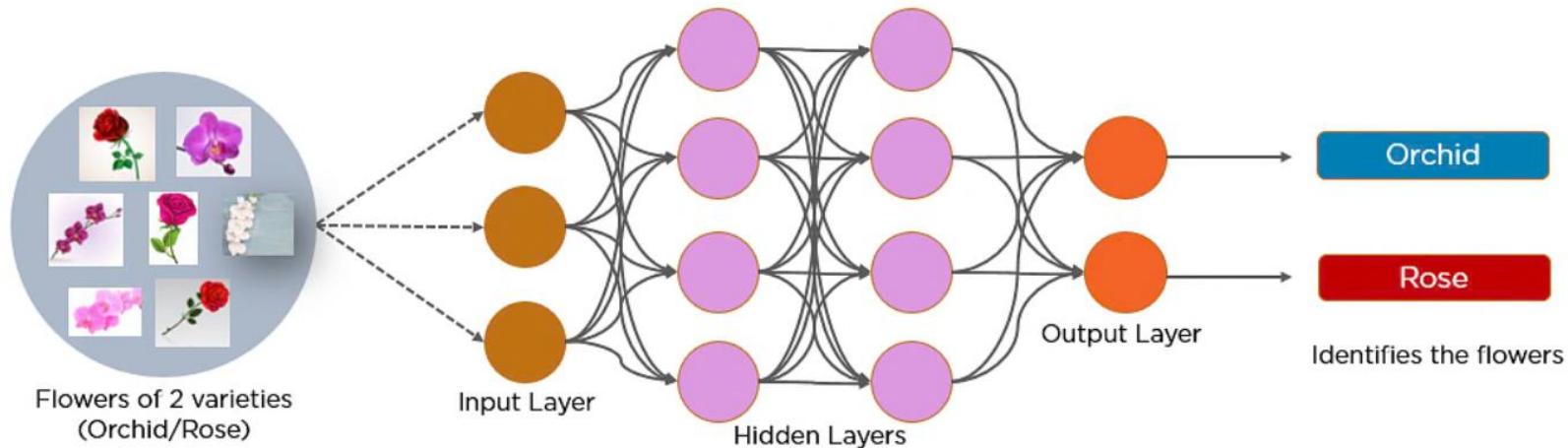
Introduction to CNN

- Imagine an image of a bird, and you want to identify whether it's a bird or some other object.
- The first thing you do is feed the pixels of the image in the form of arrays to the input layer of the neural network.



What is CNN?

- CNN is a feed-forward neural network that analyzes visual images by processing data with grid-like topology.

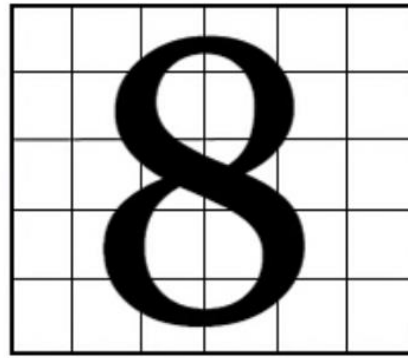


What is CNN?

- The convolution operation forms the basis of any CNN.



Real Image of the digit 8



Represented in the form
of an array



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

Digit 8 represented in the form
of pixels of 0's and 1's

Image Recognition by CNN

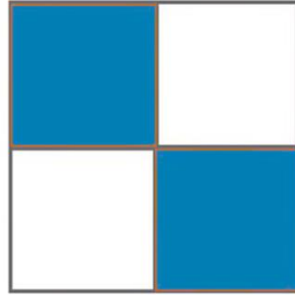


image for the symbol \

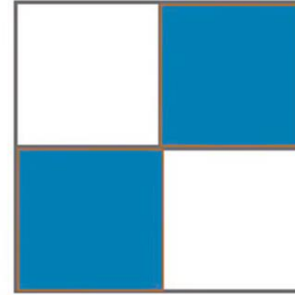
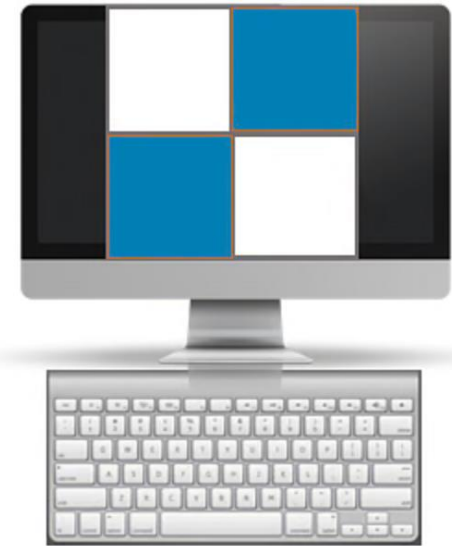


image for the symbol /



When you press \, the above image is processed

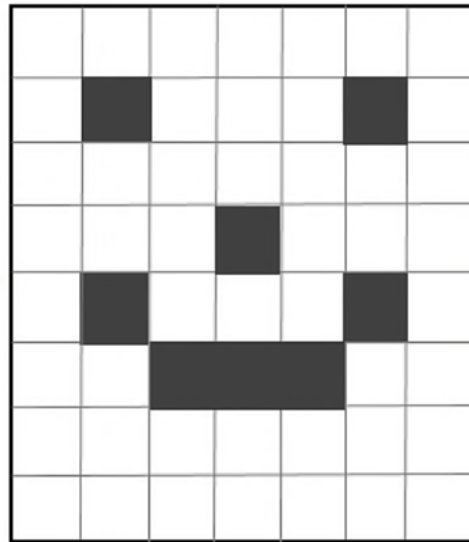


When you press /, the above image is processed

Image Recognition by CNN



Real Image



Represented in the form of
black and white pixels



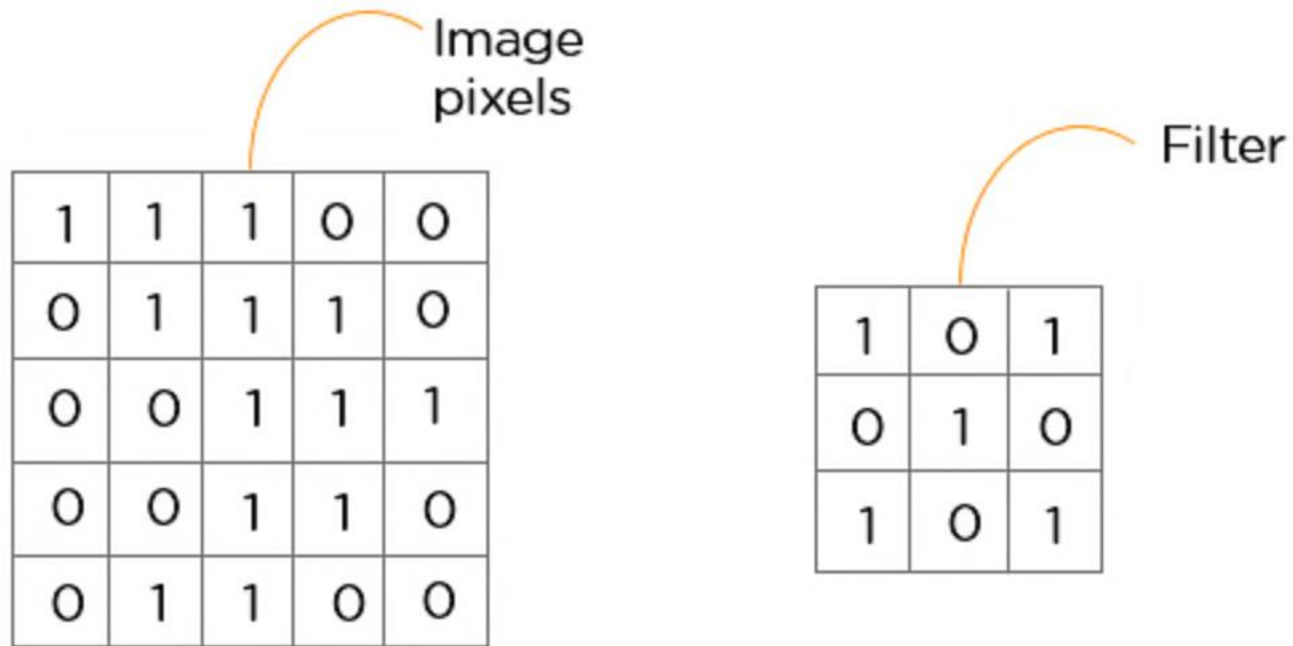
0	0	0	0	0	0	0
0	1	0	0	0	1	0
0	0	0	0	0	0	0
0	0	0	1	0	0	0
0	1	0	0	0	1	0
0	0	1	1	1	0	0
0	0	0	0	0	0	0
0	0	0	0	0	0	0

Image represented in the
form of a matrix of numbers

Layers in CNN

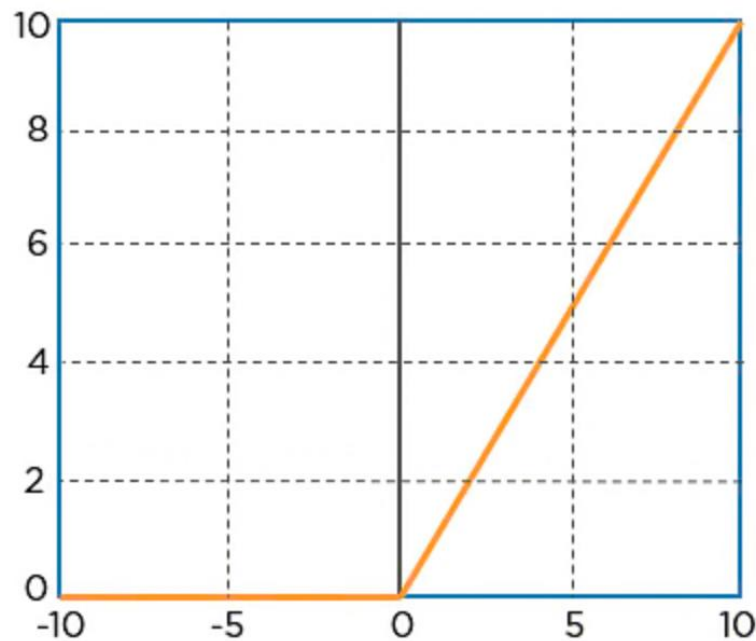
Convolutional Layer

- A convolution layer has several filters that perform the convolution operation.



ReLU Layer

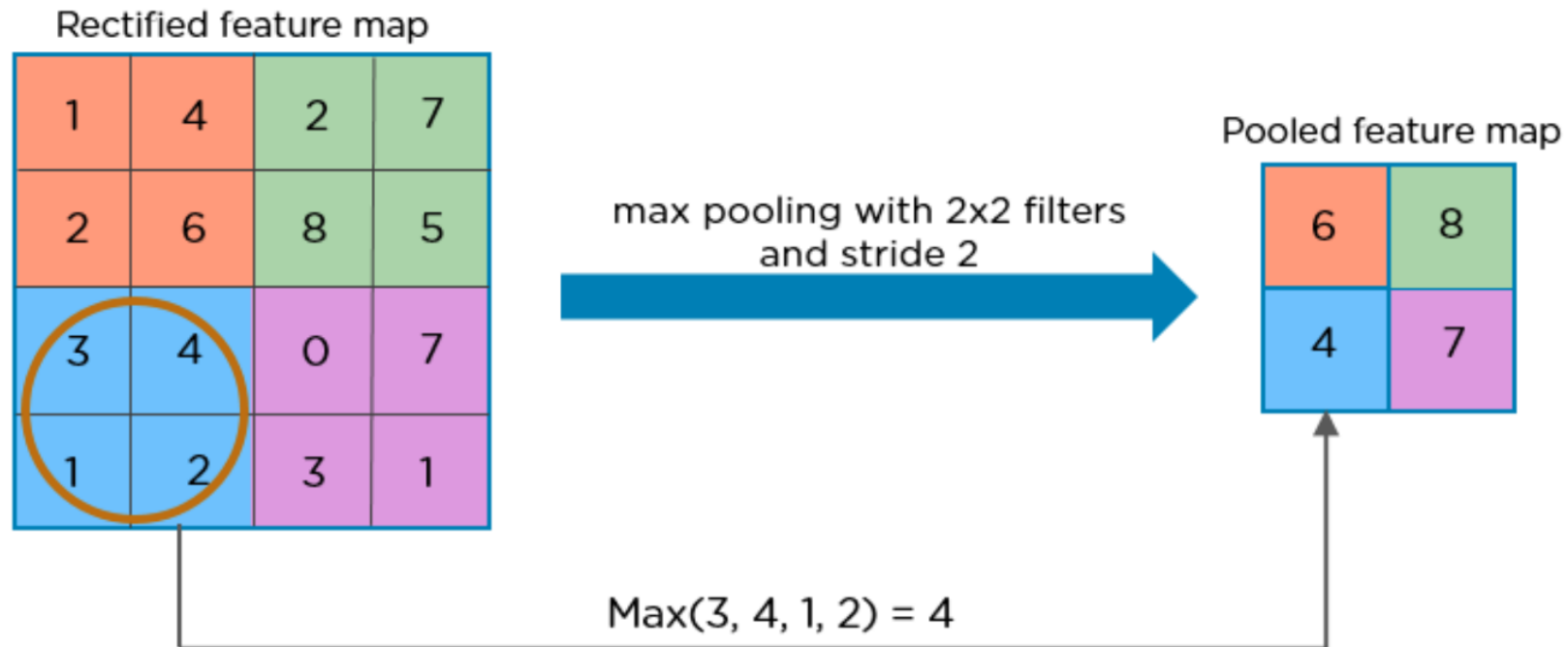
- ReLU performs an element-wise operation and sets all the negative pixels to 0.



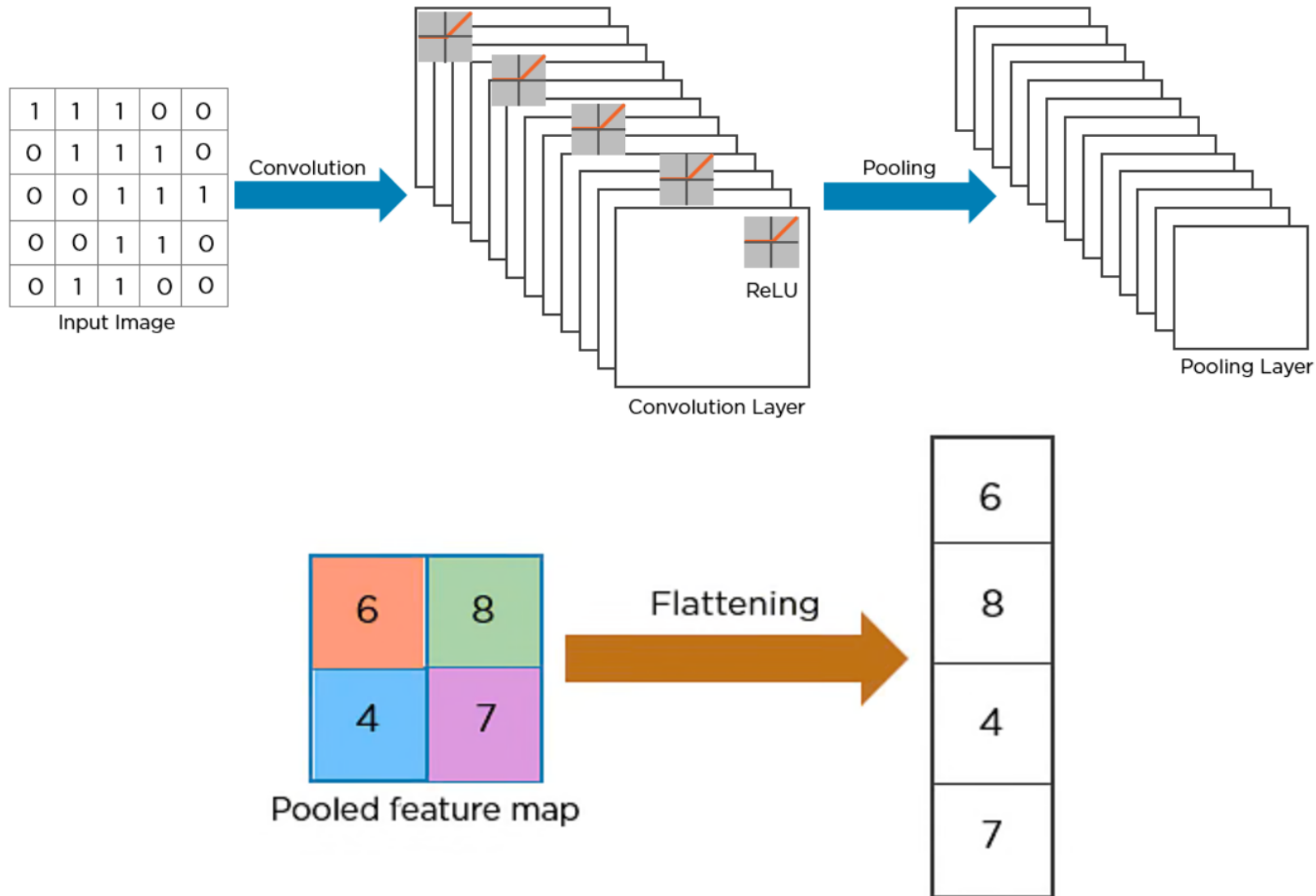
$$R(z) = \max(0, z)$$

Pooling Layer

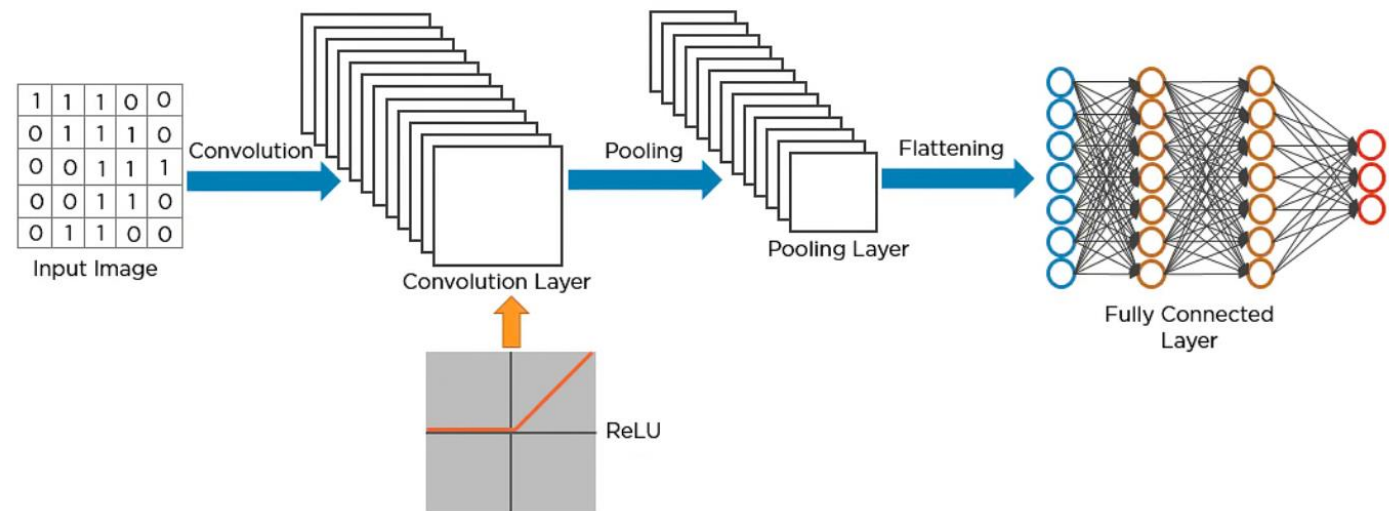
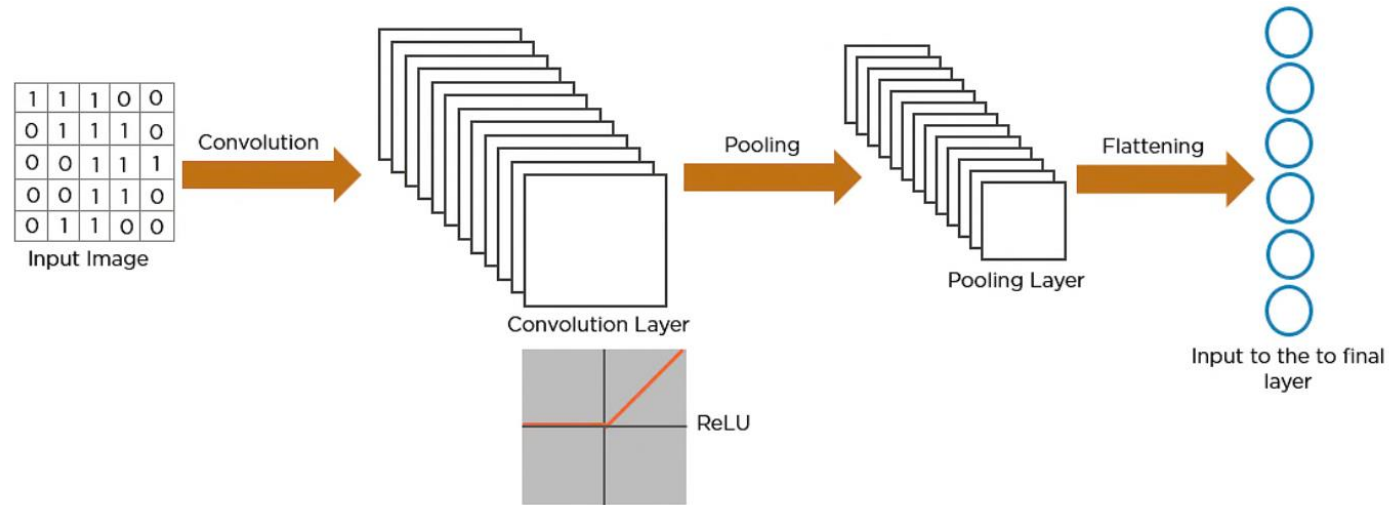
- Pooling reduces the dimensionality of the feature map.



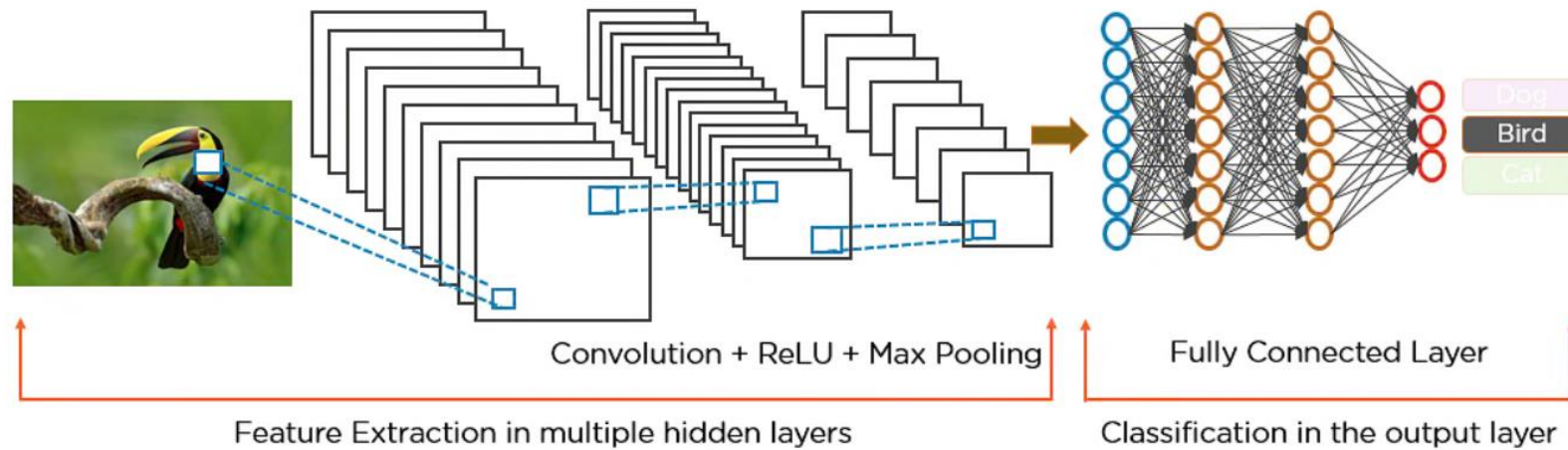
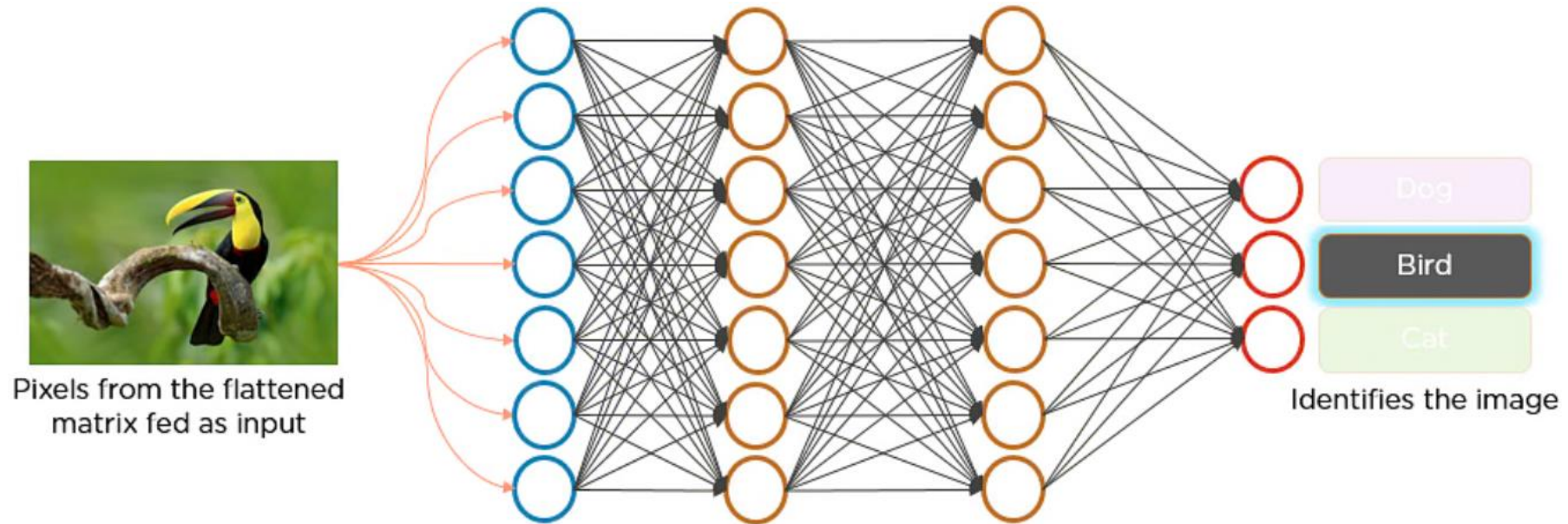
CNN Structure so far...



CNN Structure so far...



CNN Structure so far...



CNN Other layers

- The activation layer introduces nonlinearity into the network by applying an activation function to the previous layer's output.
- Flattening converts these feature maps into a one-dimensional vector.
- The result from the fully connected layers is processed in the output layer through a logistic function, such as sigmoid or softmax.

CNN Training

CNN Training

- **Data preparation** means making sure all the images are uniform in terms of format and size.
- **Loss function** is used to figure out how well CNN is doing.
- **Optimizer** adjusts the network's weights to help it do better.
- **Backpropagation** is figuring out how much each weight in the network contributed to the errors and then adjusting those weights accordingly.

CNN Evaluation

CNN Evaluation

- **Accuracy** tells you the overall percentage of test images that the CNN correctly classifies.
- **Precision** focuses on how precise the CNN is when it predicts a class.
- **Recall** looks at how well the CNN identifies all instances of a class.
- **F1 Score** combines precision and recall into a metric by calculating their harmonic mean.

CNN Types

CNN Types

- **LeNet** was designed for handwritten digit recognition.
- **AlexNet** revolutionized image recognition by winning ILSVRC.
- **ResNet** introduced the concept of residual connections, allowing deep networks to be trained without overfitting.
- **GoogleNet** introduces the Inception module, allowing the network to process features at multiple scales simultaneously.
- **MobileNet** is designed for mobile and embedded devices, offering a balance of high accuracy and computational efficiency.
- **VGG** uses a series of convolutional and pooling layers followed by fully connected layers.

Applications of CNN

CNN Applications

- **Image Classification:** CNN excels at image classification in deep learning, which involves sorting images into predefined categories.
- **Object Detection:** CNNs are exceptionally skilled in object detection, allowing them to identify and pinpoint specific items within an image.
- **Image Segmentation:** CNNs can distinguish and label different objects or regions within an image.
- **Video Analysis:** CNNs are adept at video analysis, where they can track objects and detect events over time.

Advantages and Disadvantages of CNNs

CNN Advantages

- High Accuracy
- Efficiency
- Robustness
- Flexibility

CNN Disadvantages

- Complexity and Training Difficulty
- High Computational Demands
- Large Data Requirements
- Lack of Interpretability