Teaching the Fundamentals of Computer Vision and Deep Learning

Debasis Bhattacharya, JD, DBA
University of Hawaii Maui College

ATE 2019 – Breakfast Roundtable

debasisb@wawaii.edu
http://maui.hawaii.edu/cybersecurity

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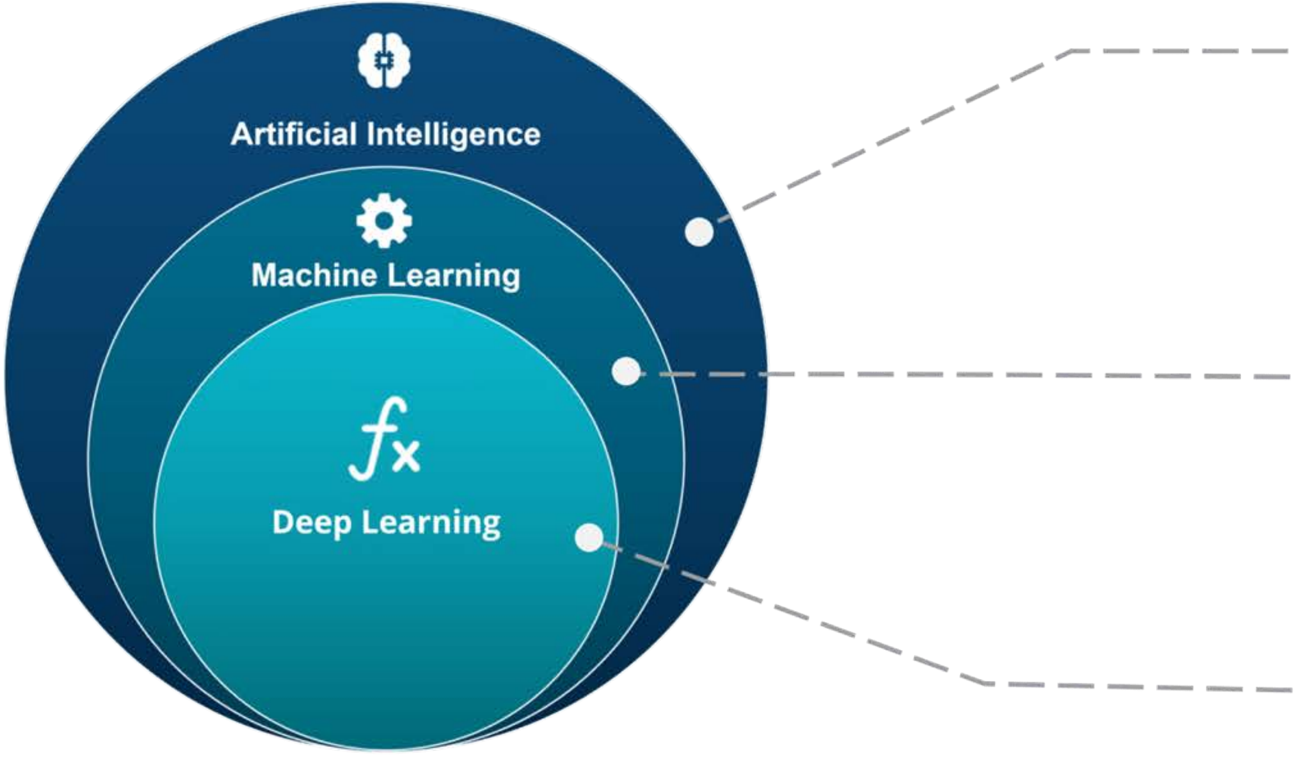
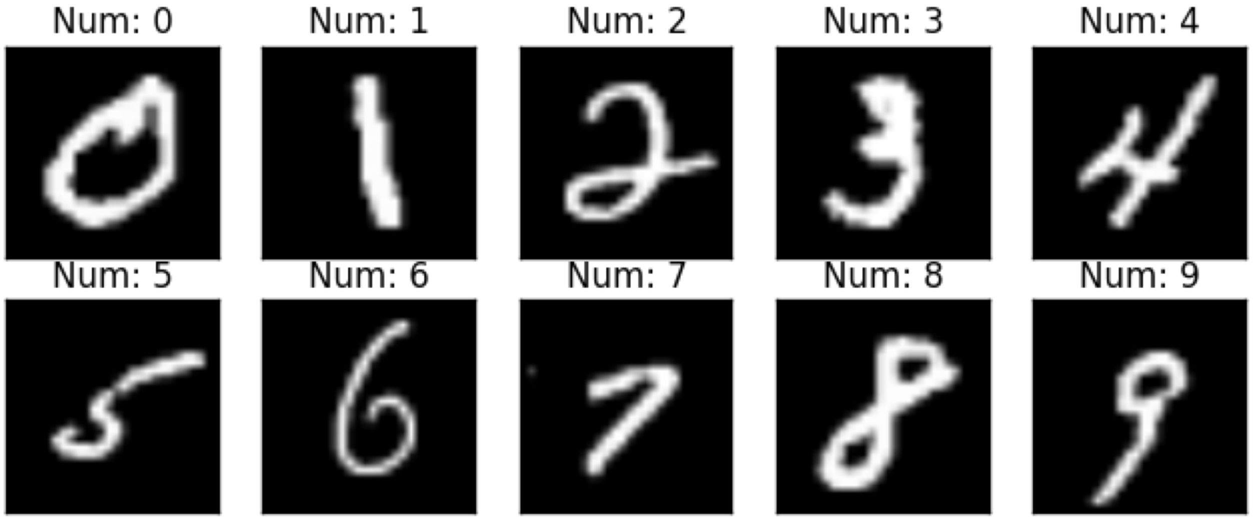


ARTIFICIAL INTELLIGENCE
A technique which enables machines to mimic human behaviour

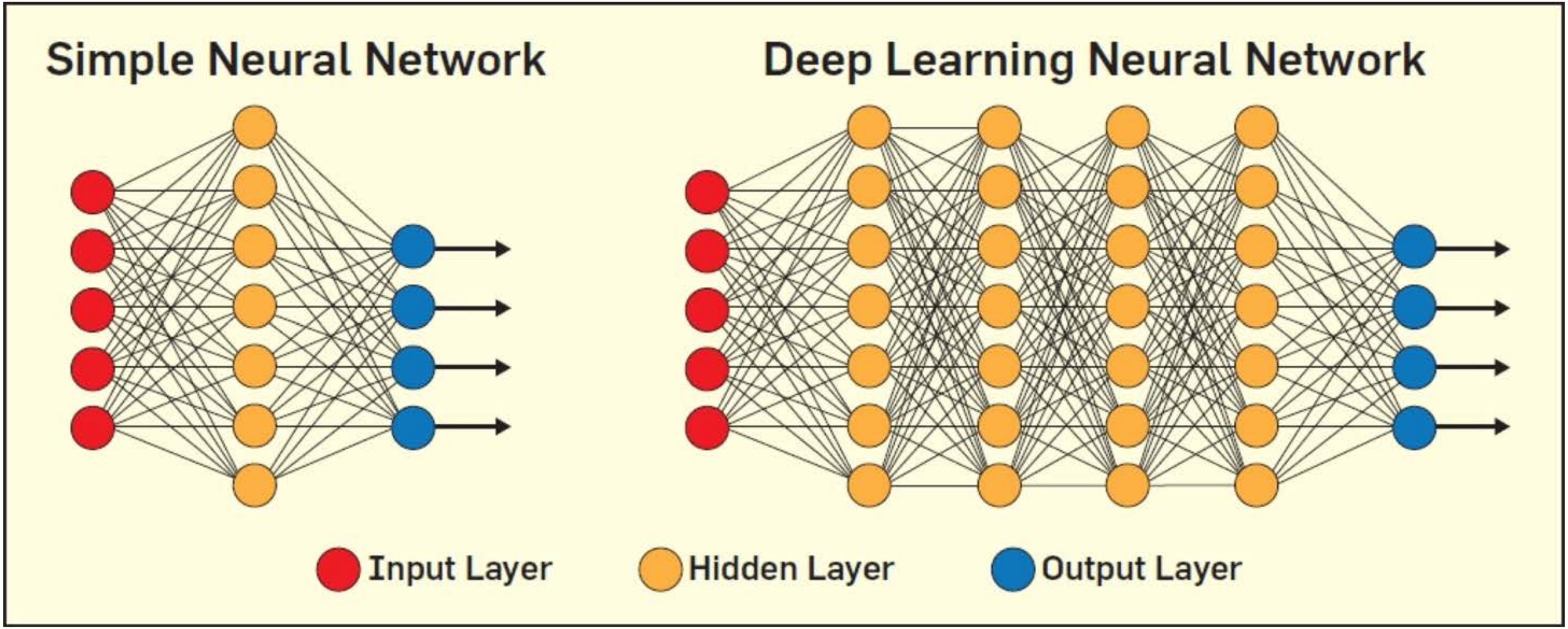
MACHINE LEARNING
Subset of AI technique which use statistical methods to enable machines to improve with experience

DEEP LEARNING
Subset of ML which make the computation of multi-layer neural network feasible

Source: Edureka

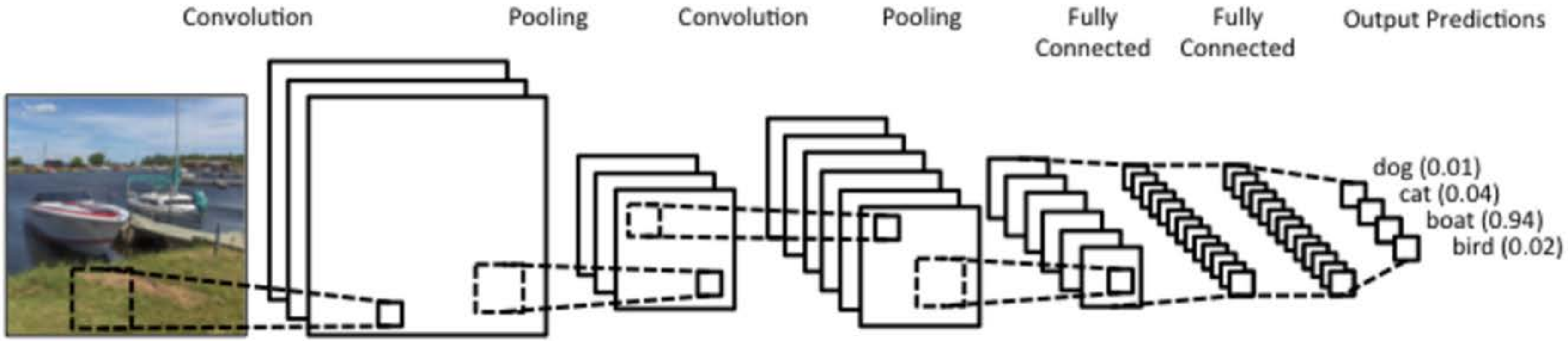


Source: TensorFlow for R - RStudio



Source: [ACM - Computers in Entertainment - Association for Computing Machinery]

Convolutional Neural Network - ConvNet



Source: https://ujjwalkarn.me/2016/08/11/intuitive-explanation-convnets/

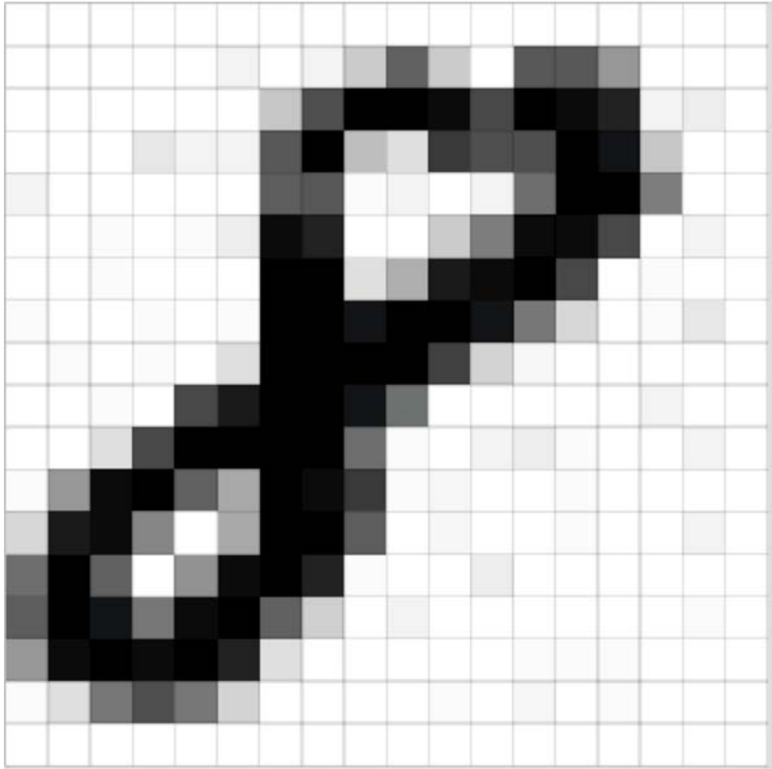


Image - Matrix of Pixels

Channels - Color images have 3 channels - RGB. Each Pixel Value ranges from 0 to 255

Grayscale Image - One channel, values 0 (white) to 255 (black)

Source: https://ujjwalkarn.me/2016/08/11/intuitive-explanation-convnets/

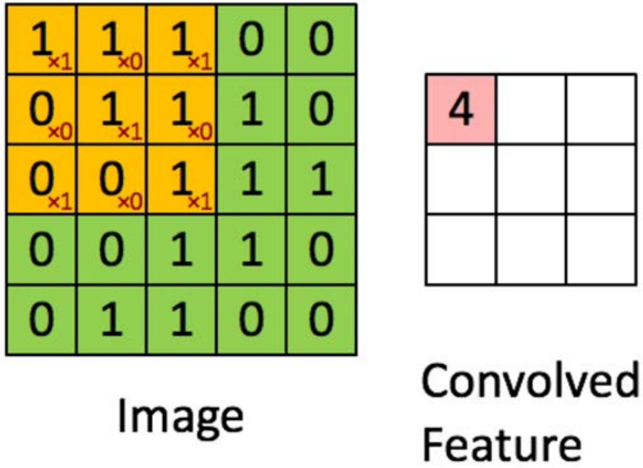
Convolution - Extract Features

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

Input Image, 5x5

1	0	1
0	1	0
1	0	1

3x3 Filter,
or Kernel
or Feature
Detector

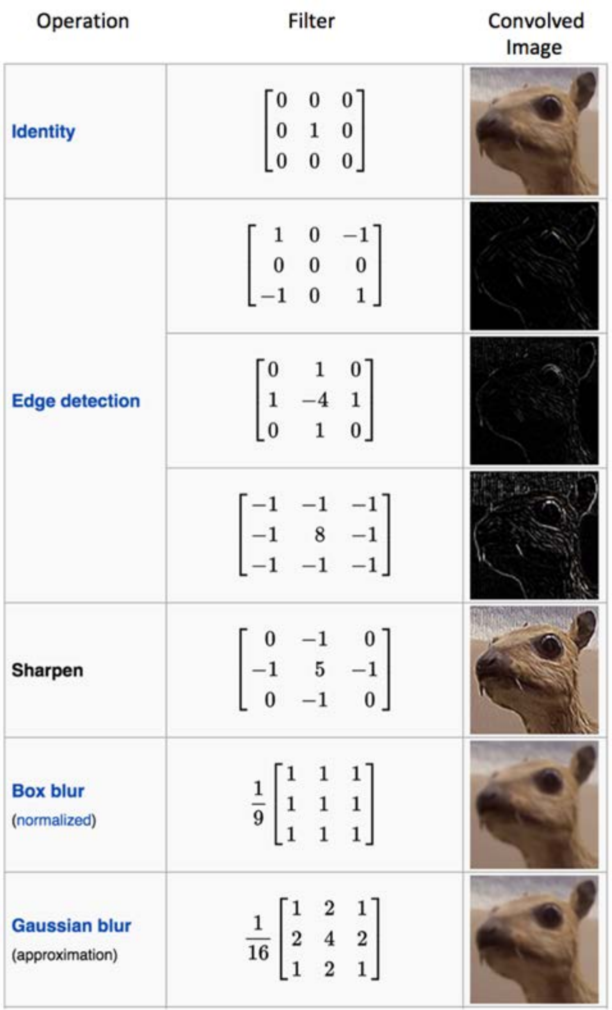


$1_{\times 1}$	$1_{\times 0}$	$1_{\times 1}$	0	0
$0_{\times 0}$	$1_{\times 1}$	$1_{\times 0}$	1	0
$0_{\times 1}$	$0_{\times 0}$	$1_{\times 1}$	1	1
0	0	1	1	0
0	1	1	0	0

4		

Move 3x3 Filter over 5x5 Input Image, one pixel at a time (STRIDE) and compute matrix multiplication. Convolved Feature or Feature Map

Source: https://ujjwalkarn.me/2016/08/11/intuitive-explanation-convnets/



Operation	Filter	Convolved Image
Identity	$\begin{bmatrix} 0 & 0 & 0 \\ 0 & 1 & 0 \\ 0 & 0 & 0 \end{bmatrix}$	
Edge detection	$\begin{bmatrix} 1 & 0 & -1 \\ 0 & 0 & 0 \\ -1 & 0 & 1 \end{bmatrix}$	
	$\begin{bmatrix} 0 & 1 & 0 \\ 1 & -4 & 1 \\ 0 & 1 & 0 \end{bmatrix}$	
	$\begin{bmatrix} -1 & -1 & -1 \\ -1 & 8 & -1 \\ -1 & -1 & -1 \end{bmatrix}$	
Sharpen	$\begin{bmatrix} 0 & -1 & 0 \\ -1 & 5 & -1 \\ 0 & -1 & 0 \end{bmatrix}$	
Box blur (normalized)	$\frac{1}{9}\begin{bmatrix} 1 & 1 & 1 \\ 1 & 1 & 1 \\ 1 & 1 & 1 \end{bmatrix}$	
Gaussian blur (approximation)	$\frac{1}{16}\begin{bmatrix} 1 & 2 & 1 \\ 2 & 4 & 2 \\ 1 & 2 & 1 \end{bmatrix}$	

Different values of the Filter or Kernel will create different Feature Maps from the Input Image

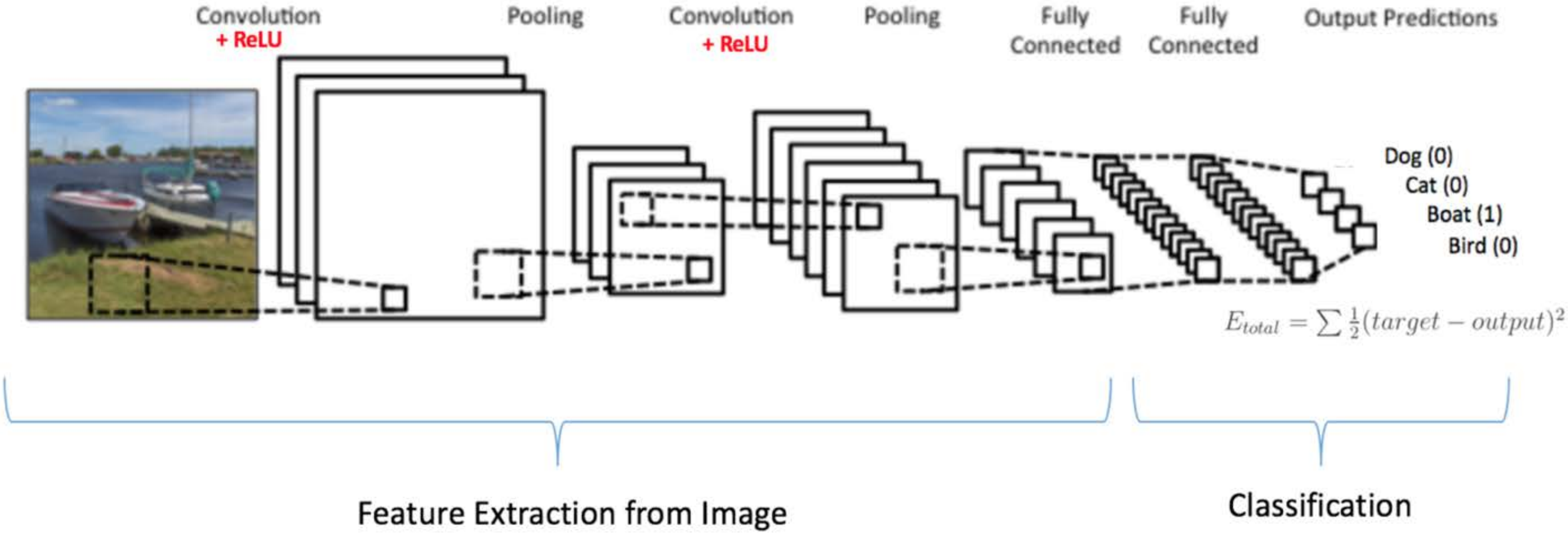
Examples of Features - Edges, Blurs, Sharpen

Parameters

Depth - # of Filters
Stride - movement across image
Zero-Padding - apply filter to edges

Source: https://ujjwalkarn.me/2016/08/11/intuitive-explanation-convnets/

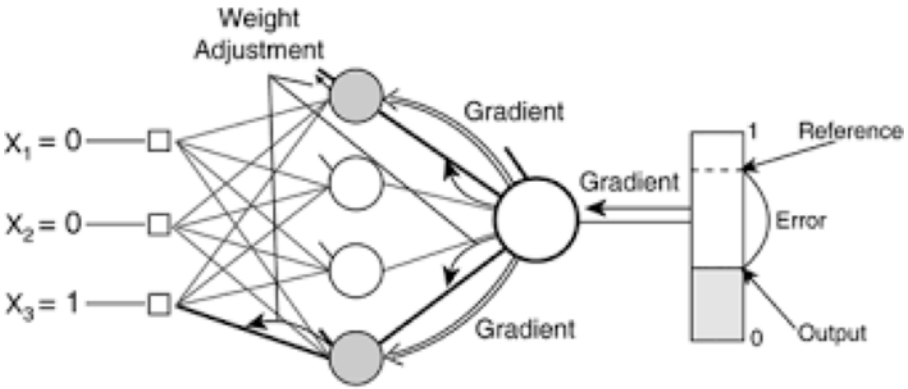
Forward Propagation

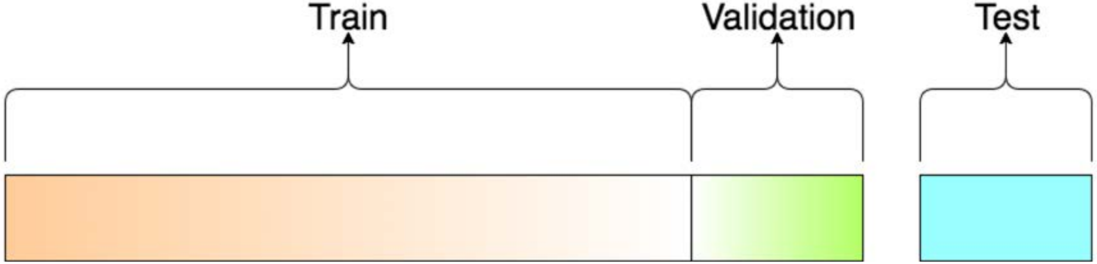


Source: https://ujjwalkarn.me/2016/08/11/intuitive-explanation-convnets/

Backward Propagation

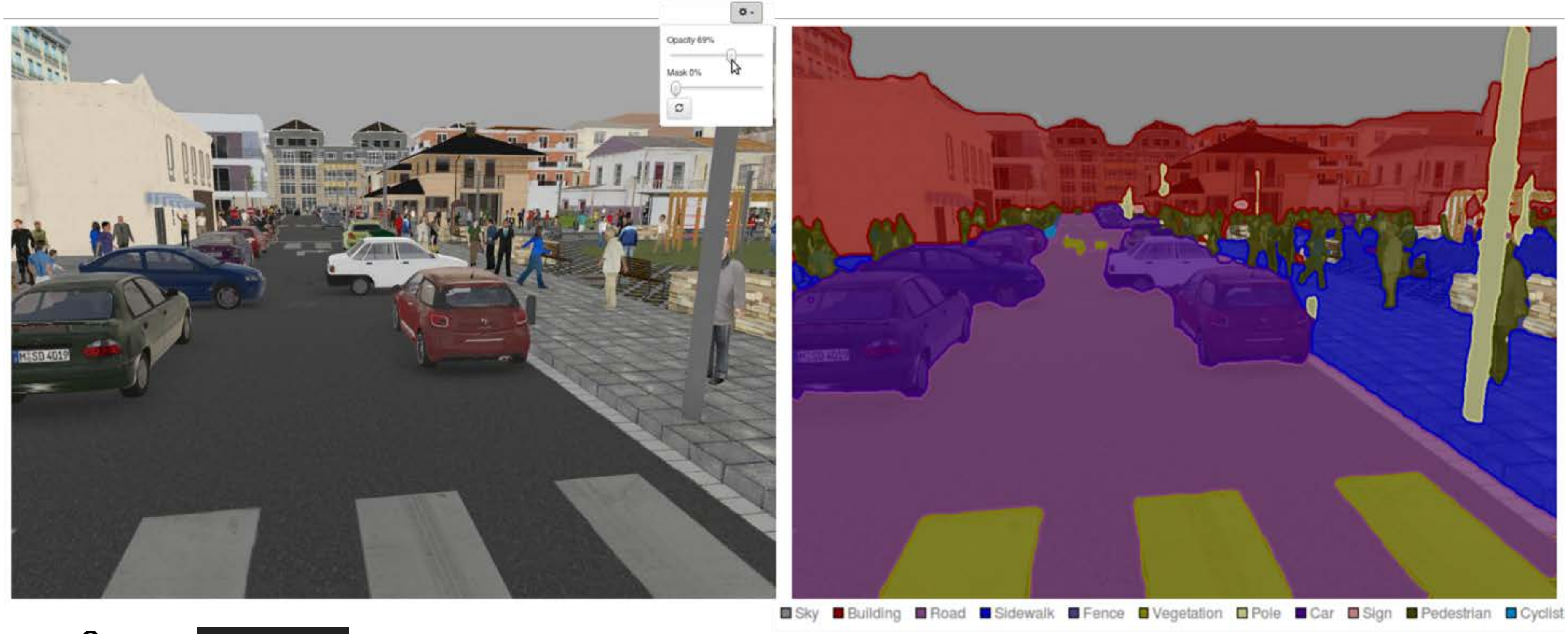
Calculate Gradient of error
Use Gradient Descent to update filter weights
Reduce Output Error or **Training Loss**
Epoch = Forward + Backward Propagation
Hyperparameter = Learning Rate
Validation Data -> Forward Propagation Only
Minimize Training Loss & Validation Loss
Control Overfitting using Dropouts
Allow for Generalization of New Test Data





Source: https://ujjwalkarn.me/2016/08/11/intuitive-explanation-convnets/

Image Segmentation using CNN



Opacity 69%

Mask 0%

Source: Good Audience

Harness AI at the Edge with the Jetson TX2 Developer Kit

The Jetson TX2 Developer Kit gives you a fast, easy way to develop hardware and software for the Jetson TX2 AI supercomputer on a module. It exposes the hardware capabilities and interfaces of the developer board, comes with design guides and other documentation, and is pre-flashed with a Linux development environment. It also supports NVIDIA Jetpack—a complete SDK that includes the BSP, libraries for deep learning, computer vision, GPU computing, multimedia processing, and much more.