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
October 25, 2019
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
Convolutional Neural Network - ConvNet

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

Convolved Feature or Feature Map

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

<table>
<thead>
<tr>
<th>Operation</th>
<th>Filter</th>
<th>Convolved Image</th>
</tr>
</thead>
<tbody>
<tr>
<td>Identity</td>
<td>$\begin{bmatrix} 0 &amp; 0 &amp; 0 \ 0 &amp; 1 &amp; 0 \ 0 &amp; 0 &amp; 0 \end{bmatrix}$</td>
<td><img src="https://example.com" alt="Image" /></td>
</tr>
<tr>
<td>Edge detection</td>
<td>$\begin{bmatrix} 0 &amp; 1 &amp; 0 \ 0 &amp; 0 &amp; 0 \ -1 &amp; 0 &amp; 1 \end{bmatrix}$</td>
<td><img src="https://example.com" alt="Image" /></td>
</tr>
<tr>
<td></td>
<td>$\begin{bmatrix} 0 &amp; 1 &amp; 0 \ 1 &amp; -4 &amp; 1 \ 0 &amp; 1 &amp; 0 \end{bmatrix}$</td>
<td><img src="https://example.com" alt="Image" /></td>
</tr>
<tr>
<td></td>
<td>$\begin{bmatrix} -1 &amp; -1 &amp; -1 \ -1 &amp; 8 &amp; -1 \ -1 &amp; -1 &amp; -1 \end{bmatrix}$</td>
<td><img src="https://example.com" alt="Image" /></td>
</tr>
<tr>
<td>Sharpen</td>
<td>$\begin{bmatrix} 0 &amp; -1 &amp; 0 \ -1 &amp; 5 &amp; -1 \ 0 &amp; -1 &amp; 0 \end{bmatrix}$</td>
<td><img src="https://example.com" alt="Image" /></td>
</tr>
<tr>
<td>Box blur</td>
<td>$\text{normalized}$ $\frac{1}{9} \begin{bmatrix} 1 &amp; 1 &amp; 1 \ 1 &amp; 1 &amp; 1 \ 1 &amp; 1 &amp; 1 \end{bmatrix}$</td>
<td><img src="https://example.com" alt="Image" /></td>
</tr>
<tr>
<td>Gaussian blur</td>
<td>$\text{approximation}$ $\frac{1}{16} \begin{bmatrix} 1 &amp; 2 &amp; 1 \ 2 &amp; 4 &amp; 2 \ 1 &amp; 2 &amp; 1 \end{bmatrix}$</td>
<td><img src="https://example.com" alt="Image" /></td>
</tr>
</tbody>
</table>
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

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.