Fundamentals of Neural Networks

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Introduction

Figure 1: A self-driving car.
Credit: Marc van der Chijs / CC BY-ND 2.0

Introduction

Figure 2: A digital assistant.
Credit: Kārlis Dambrāns / CC BY 2.0

Introduction

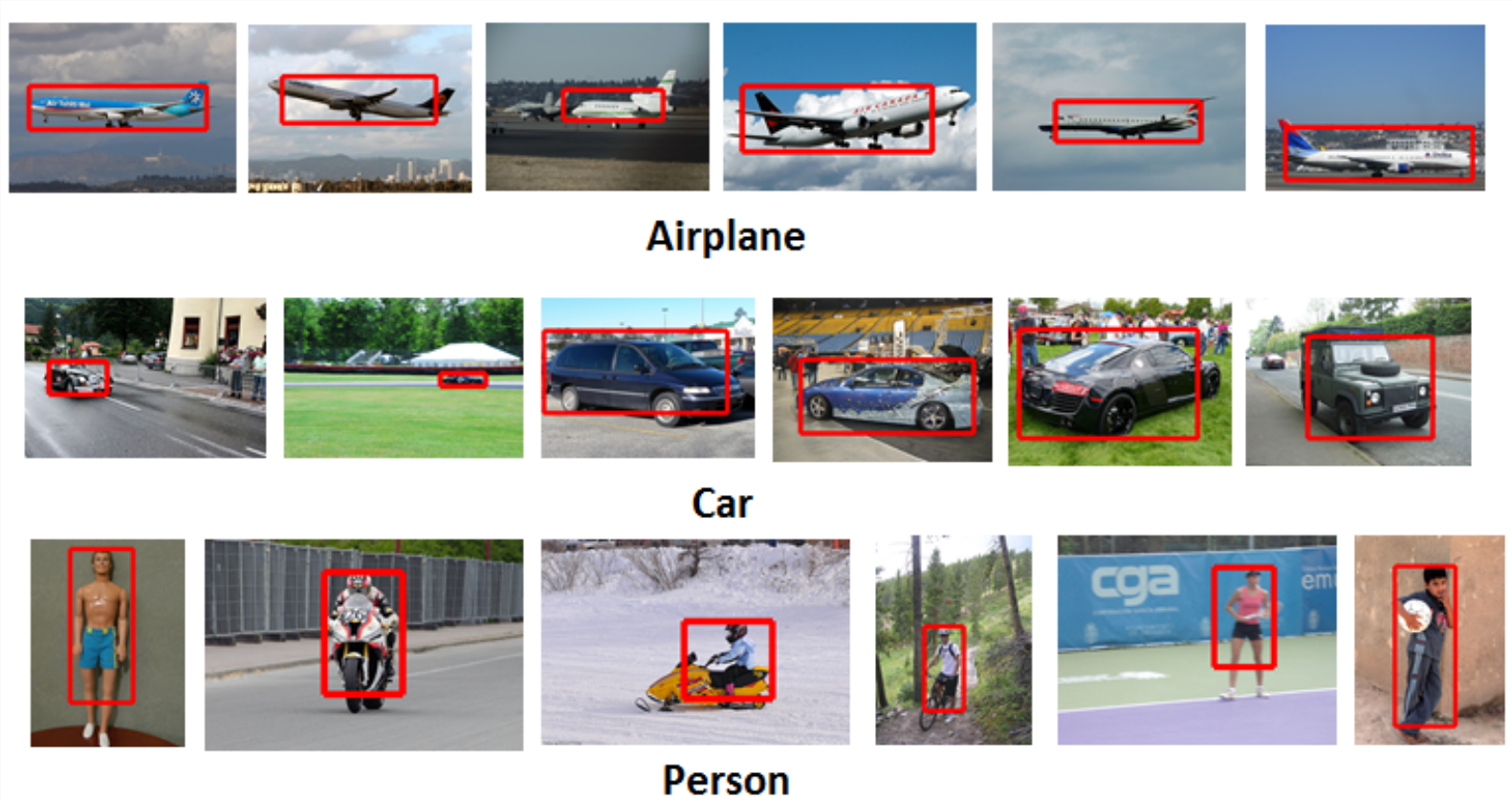

Figure 3: Object detection in images.
Credit: Lu et. al[1]

[1] "1-HKUST: Object Detection in ILSVRC 2014", *CoRR*, vol. abs/1409.6155, 2014

Outline

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1. The Perceptron
2. Feedforward Neural Networks
   - Architecture
   - Mathematical formulation
3. Training Feedforward Neural Networks
   - Cost functions
   - Stochastic Gradient Descent
   - Back-propagation
4. Extensions

The Perceptron

Example Task

- Predict whether an input image of a handwritten digit shows a zero or another digit

MNIST Data Sample

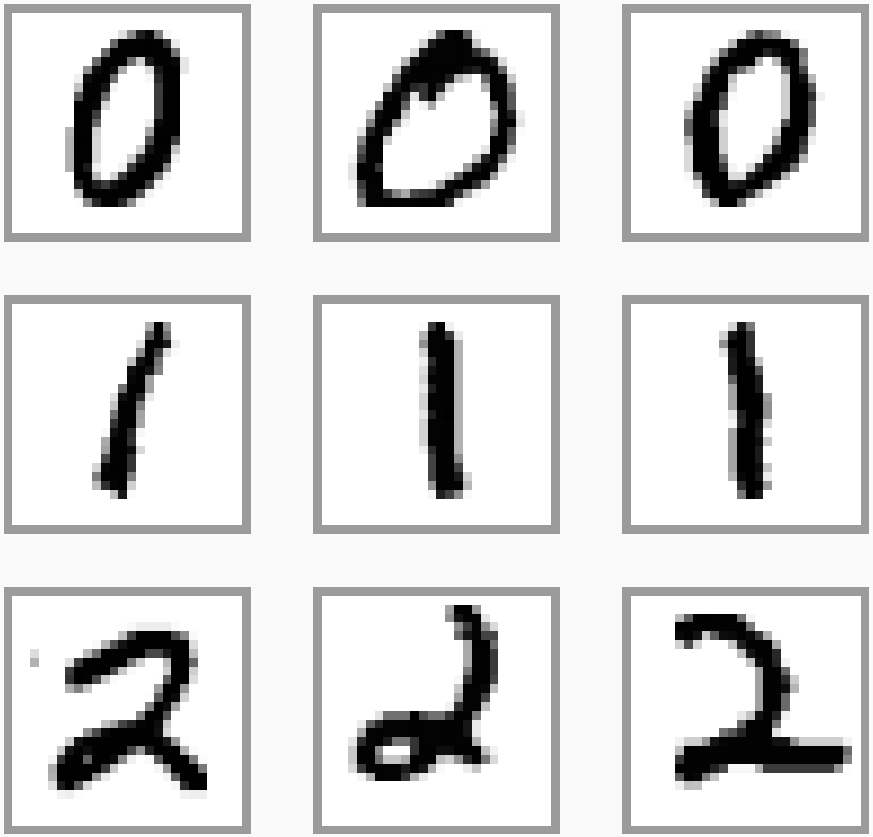

Figure 4: Examples from the MNIST database.
Credit: Josef Steppan / CC BY-SA 4.0

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- Predict whether an input image of a handwritten digit shows a zero or another digit
- The image is represented as a flattened vector of pixel intensities $\mathbf{x} \in \mathbb{R}^{784}$
- The output should be 1 if the image shows a zero, otherwise it should be -1

Model Specification

The perceptron accepts n input values and computes an output value $\hat{y}$:

$$\begin{aligned} \hat{y} &= \text{sign}\left(\sum_{i=1}^{n} w_i x_i\right) \\ \equiv \hat{y} &= \text{sign}(\mathbf{w}^\top \mathbf{x}) \end{aligned} \tag{1}$$

Feedforward Neural Networks

Training Feedforward Neural Networks

Extensions

Thank you!