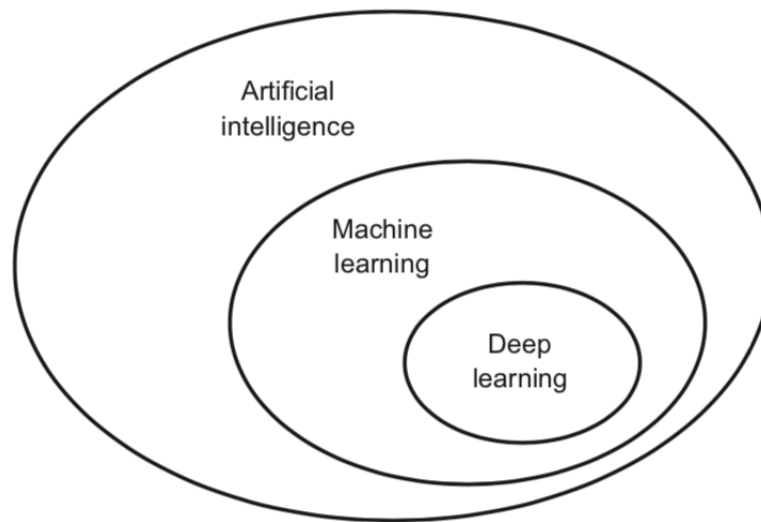# CSCE 636 Neural Networks (Deep Learning)

Lecture 1: Introduction to Deep Learning

Anxiao (Andrew) Jiang

AI, Machine Learning, and Deep Learning

Figure 1.1 Artificial intelligence, machine learning, and deep learning

Coming up: Prerequisites for the course

Prerequisites for the course

- Familiar with the Python programming language
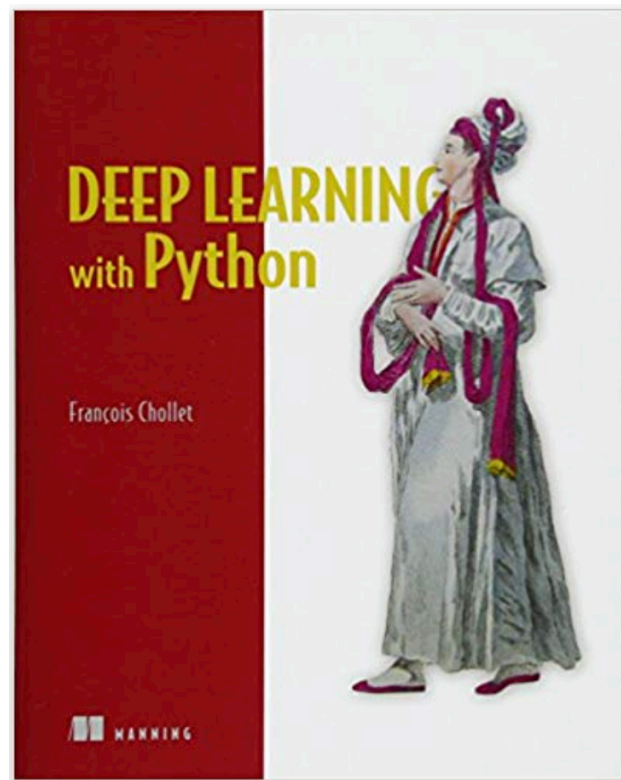- Basic background in machine learning, linear algebra, calculus.

Coming up: course website

Course website

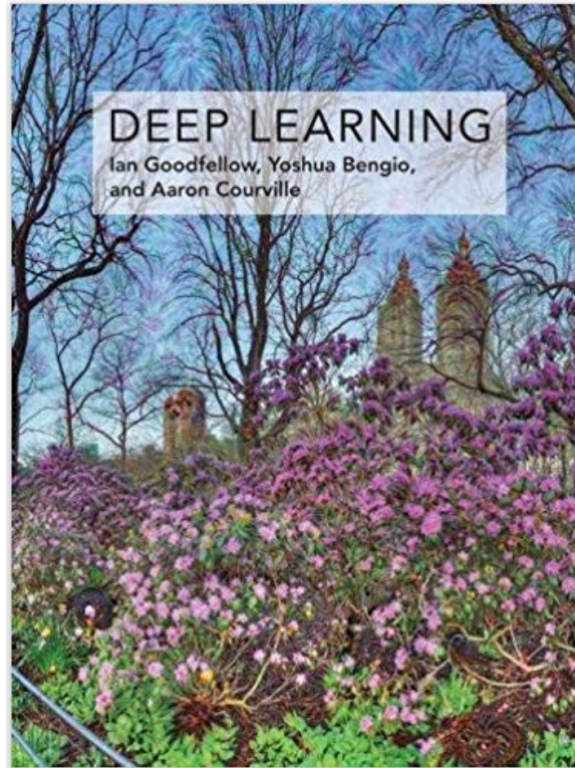- http://faculty.cse.tamu.edu/ajiang/636.html

Coming up: textbook

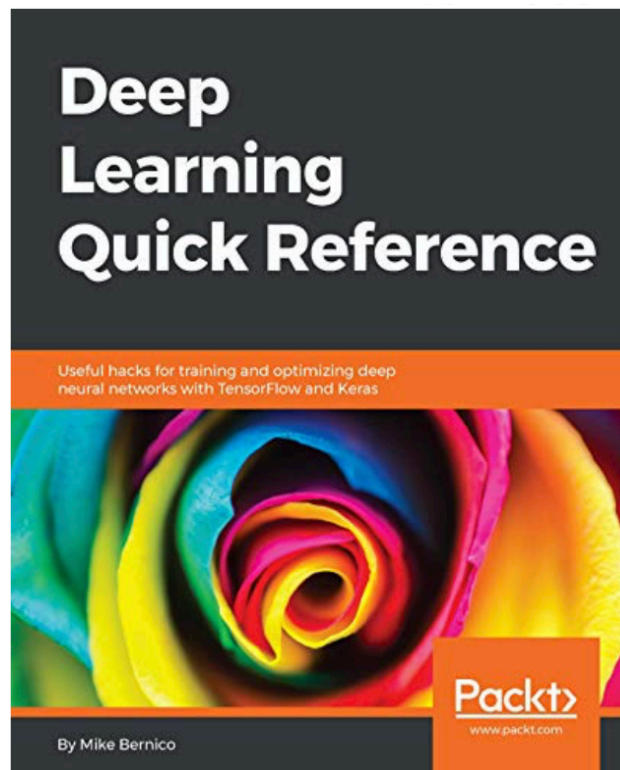# Textbook: Deep Learning with Python (required)

Coming up: textbook

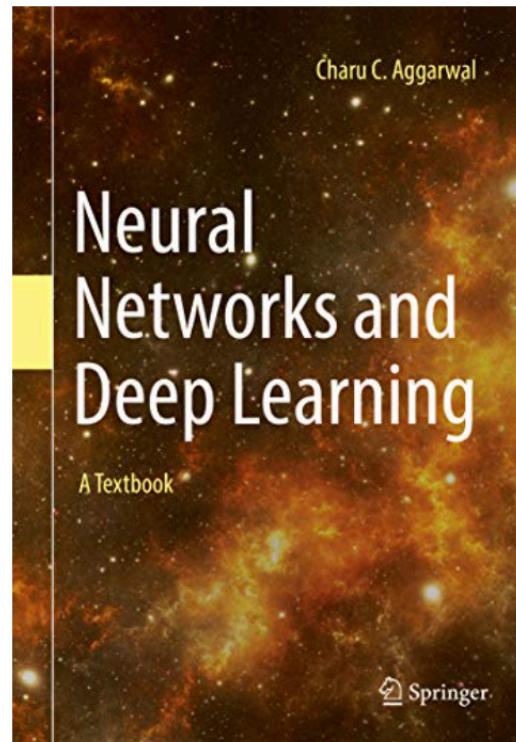# Textbook: Deep Learning (recommended)

Coming up: textbook

Textbook: Deep Learning Quick Reference (recommended)
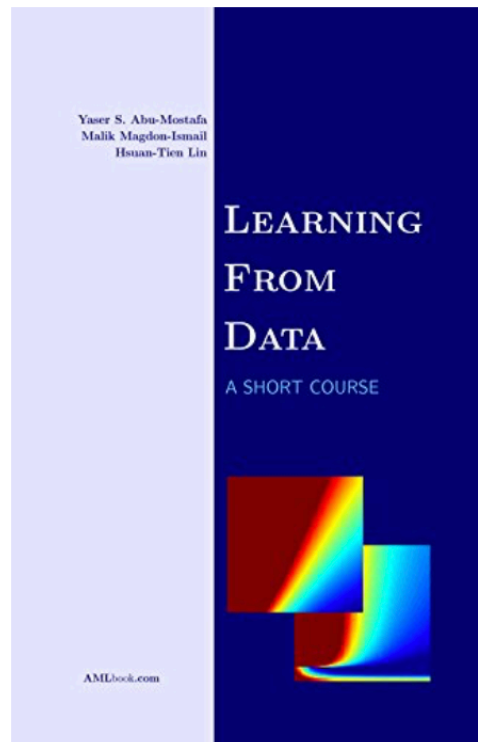

Coming up: textbook

Textbook: Neural Networks and Deep Learning (recommended)
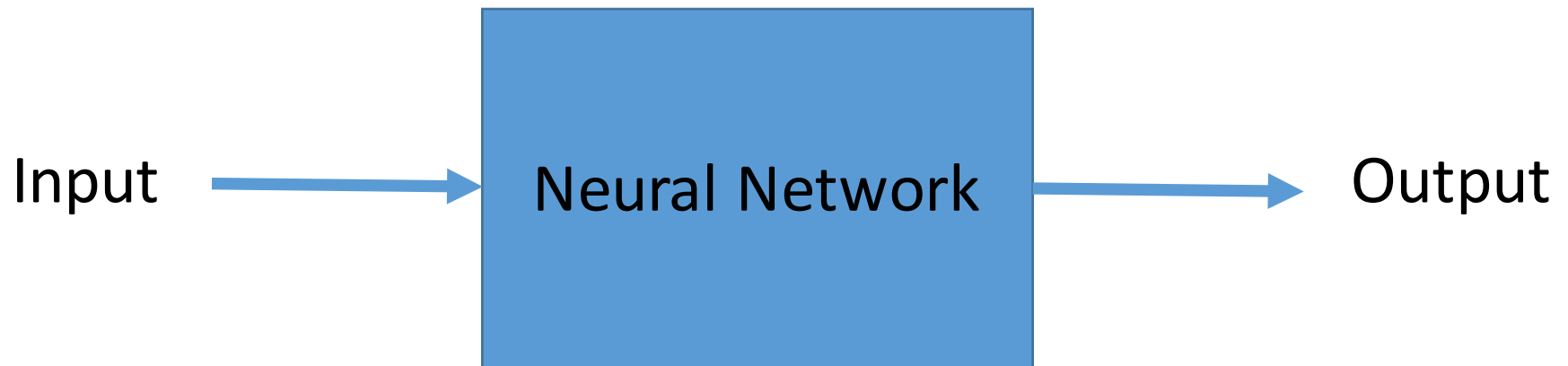

Coming up: textbook

Textbook: Learning from Data (recommended)

Coming up: deep learning and neural network

Deep Learning and Neural Network

Input → **Neural Network** → Output

What neural network is doing: computing (often transformation of features/representations, and making a final decision).

Coming up: example of transformation

Example of transformation
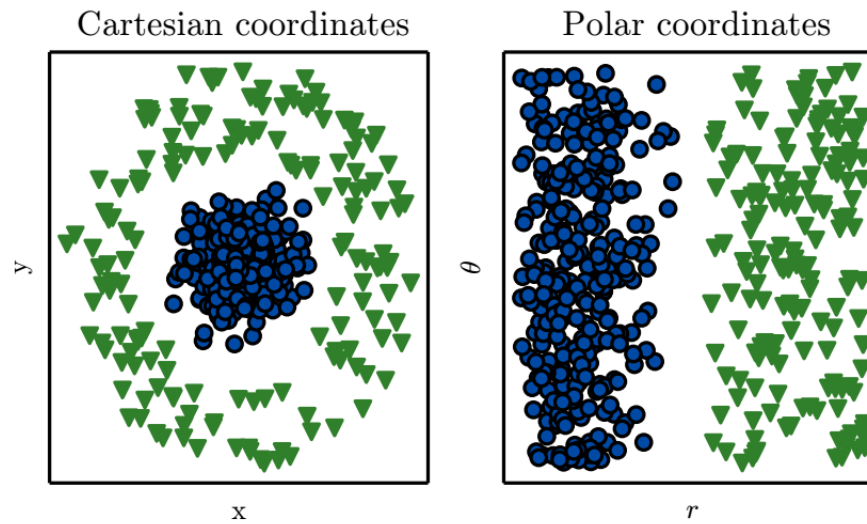

Cartesian coordinates — Polar coordinates

Figure 1.1: Example of different representations: suppose we want to separate two categories of data by drawing a line between them in a scatterplot. In the plot on the left, we represent some data using Cartesian coordinates, and the task is impossible. In the plot on the right, we represent the data with polar coordinates and the task becomes simple to solve with a vertical line. (Figure produced in collaboration with David Warde-Farley.)
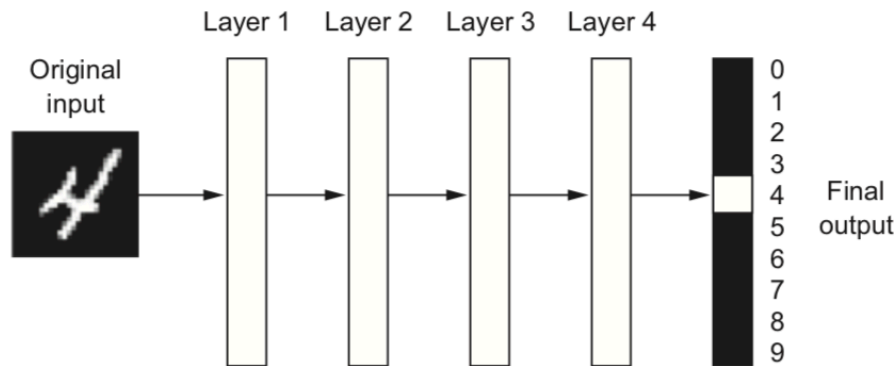
Coming up: example of transformation

Example of transformation
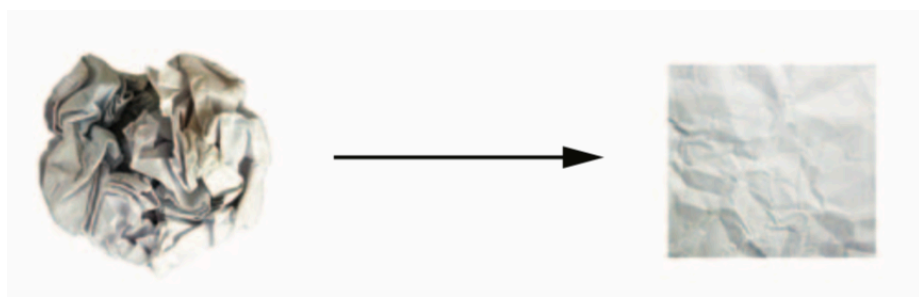
Figure 2.9   Uncrumpling a complicated manifold of data

Coming up: example of deep neural network (DNN)

Example of Deep Neural Network (DNN)

Figure 1.5 A deep neural network for digit classification

Coming up: example of DNN (continued)
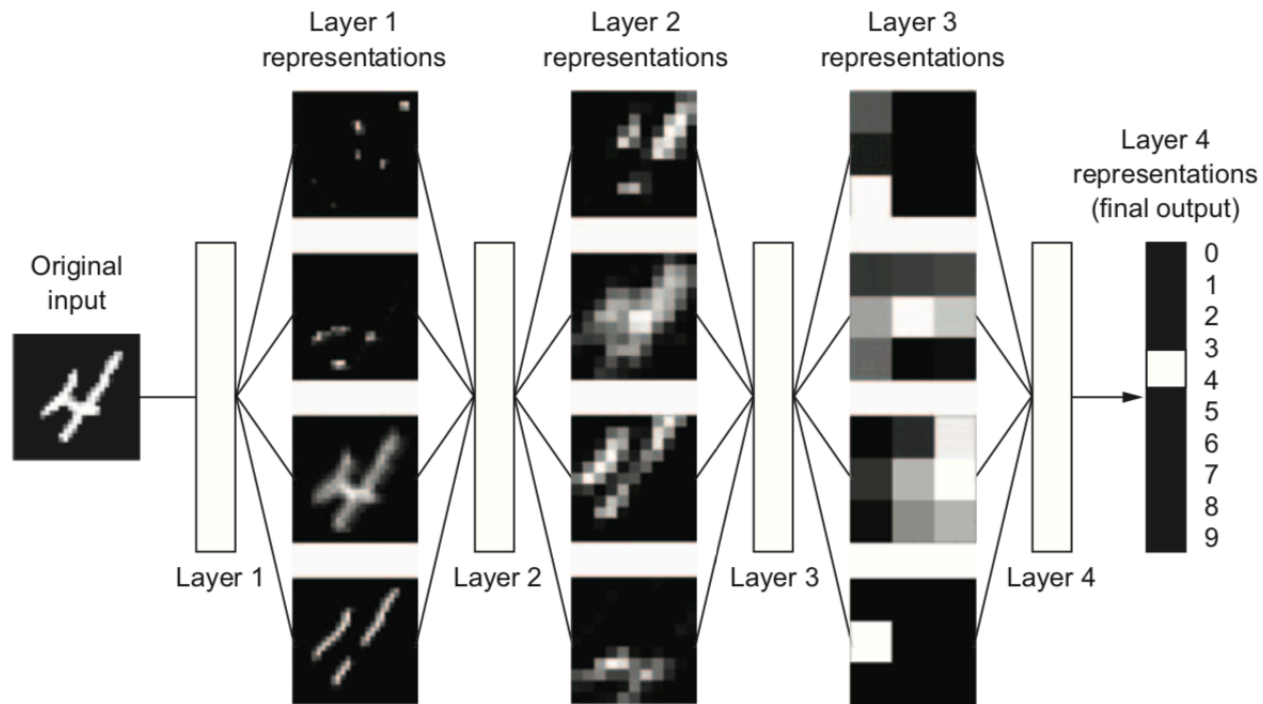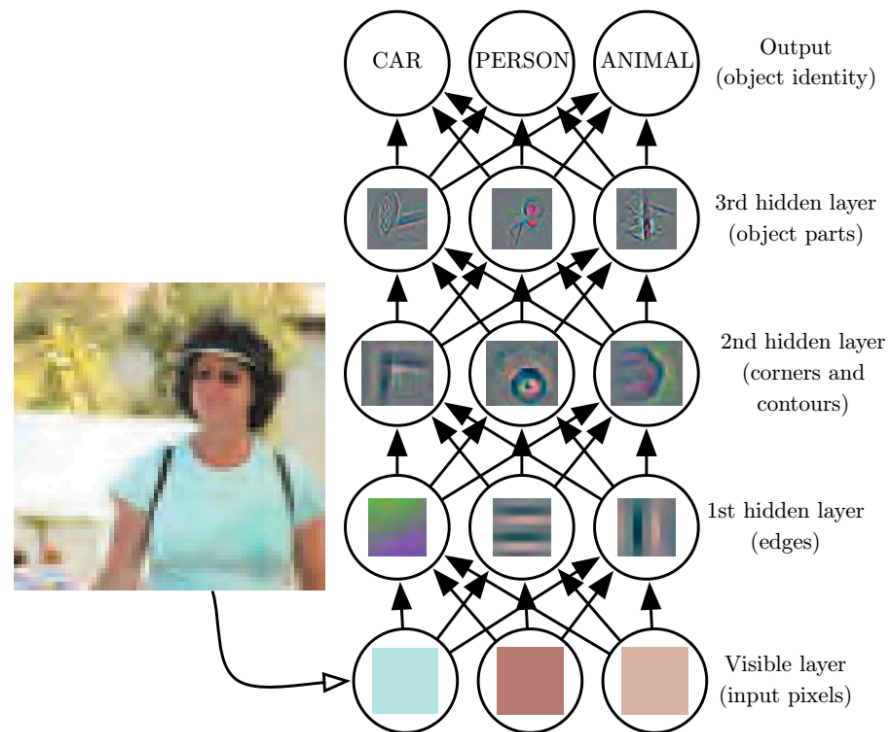
Example of DNN (continued)

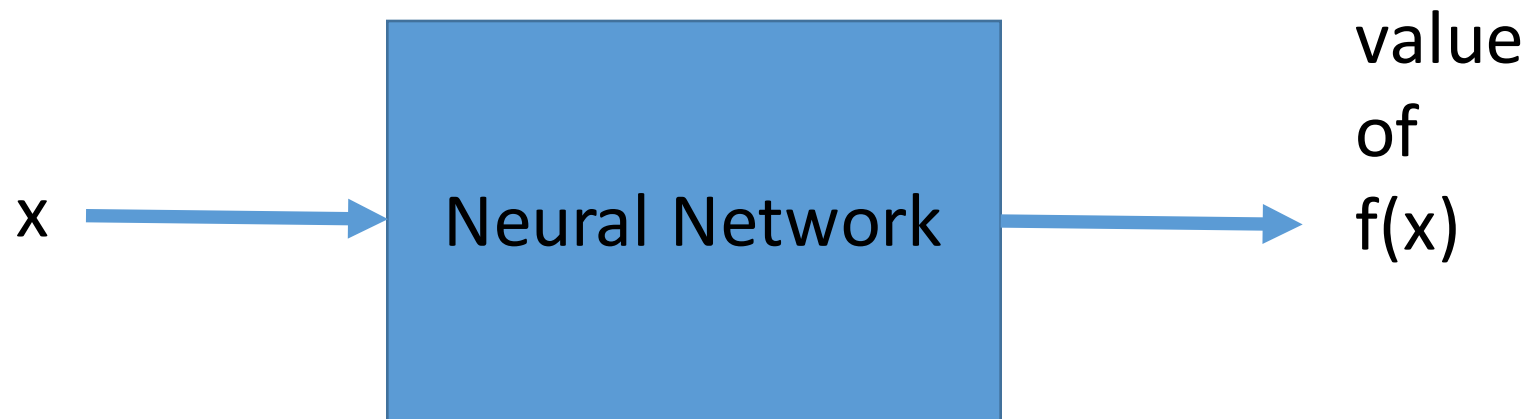Figure 1.6   Deep representations learned by a digit-classification model

Coming up: example of DNN

Example of DNN

Coming up: what a neural network does: learn a function

What a neural network does: learn a function

x → **Neural Network** → value of f(x)
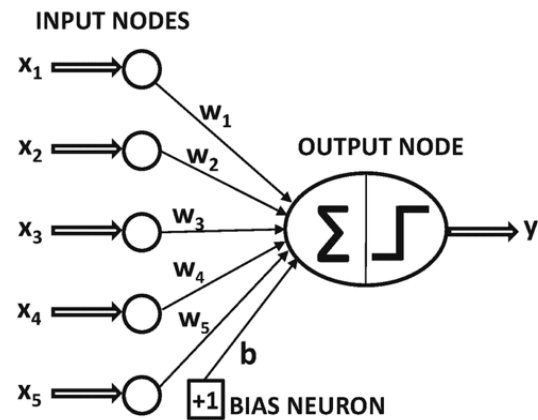
The neural network learns the function f(x),
either exactly or approximately.

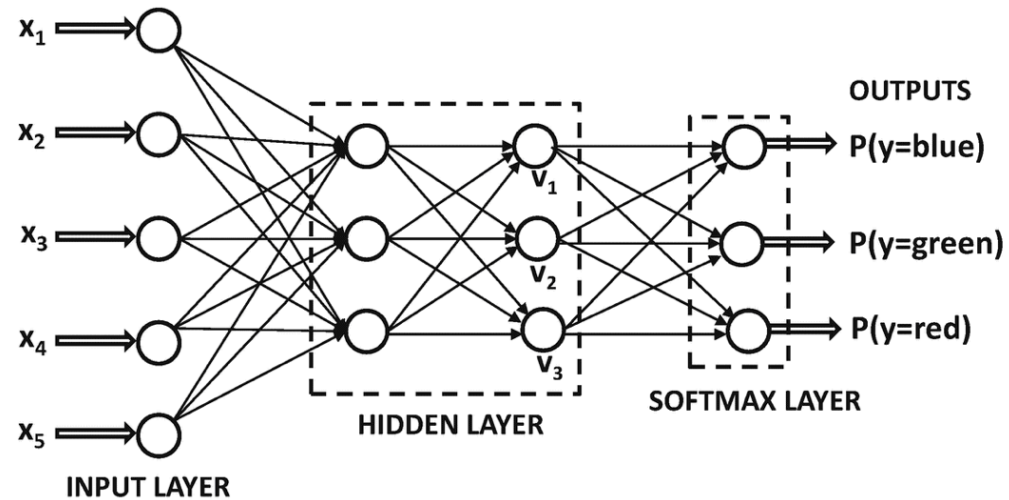Coming up: what is a neuron

What is a neuron

(b) Perceptron with bias

$$\hat{y} = \text{sign}\{\overline{W} \cdot \overline{X} + b\} = \text{sign}\{\sum_{j=1}^{d} w_j x_j + b\}$$

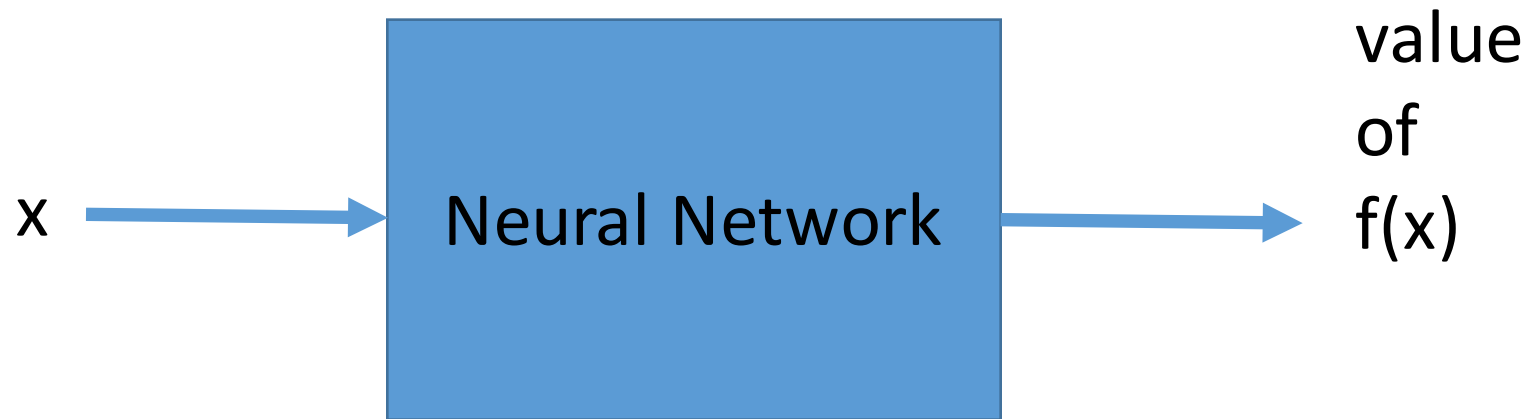Coming up: what is a neural network (NN)

What is a neural network

Figure 1.9 An example of multiple outputs for categorical classification with the use of a softmax layer

Coming up: how to train a neural network

How to train a neural network

x → Neural Network → value of f(x)

The neural network learns the function f(x),
either exactly or approximately.

1. Use a lot of (input, output) pairs to train the neural network.

2. Adjust weights to minimize the difference between f(x) and the neural network's predicted values of f(x)

Coming up: applications of deep learning

Applications of Deep Learning

- Computer vision (smart camera, robot, self-driving cars, etc.)
- Natural language processing (machine translation, chatbot, etc.)
- Game playing (alpha Go, video games, etc.)
- Create art or products (painting, music, poem, fashion, etc.)
- Data storage and transmission (data compression, transmission, etc.)
- Finance and economy (trading, recommendation, economy survey, etc.)
- Healthcare (read X-ray pictures, diagnosis, drug design, etc.)
- Physics, business, education, smart homes, etc. (More and more applications every day.)
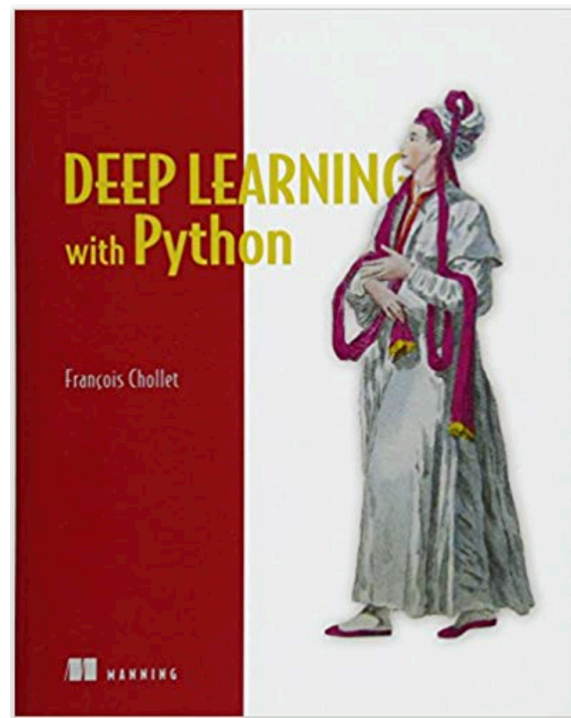
Coming up: why deep learning now?

Why deep learning now?

- Hardware: GPU, CUDA, parallel computing
- Data: ImageNet and many more
- Algorithms: activation functions, weight initialization schemes, optimization schemes for training.

Coming up: homework (without submission)

Homework (without submission)

Read Chapter 2
Before
Next
Class

Coming up: Videos on deep learning

Videos on deep learning

- How we teach computers to understand pictures,
  https://www.youtube.com/watch?v=40riCqvRoMs

- Artistic Style Transfer For Videos,
  https://www.youtube.com/watch?v=Uxax5EKg0zA

- Chopin Music Generation with RNN (Recurrent Neural Networks) and
  Deep Learning, https://www.youtube.com/watch?v=j60J1cGINX4