A decorative background pattern consisting of a network graph. It features numerous nodes, represented by small circles in various shades of gray and blue, connected by thin, light gray lines. Some nodes are highlighted with a blue outline. The pattern is distributed across the slide, with a denser concentration on the left side and a more sparse arrangement on the right.

The mathematical building blocks of neural networks

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Hello!

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1.

What is deep learning?

Artificial intelligence, machine learning, and deep learning

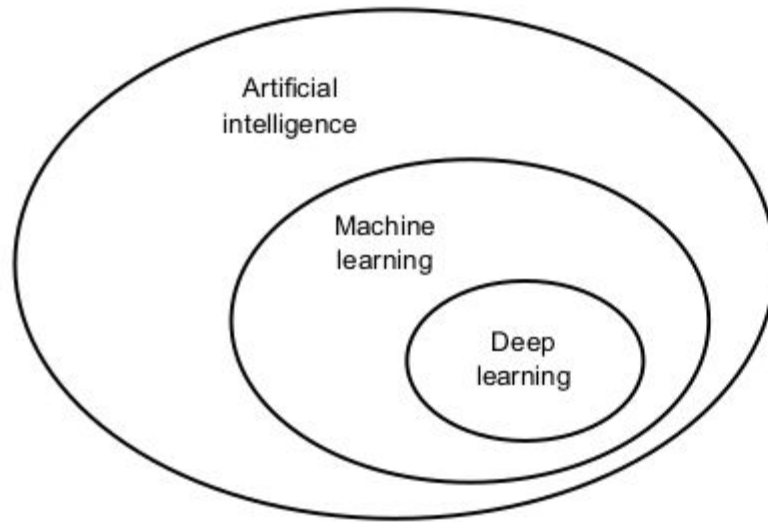
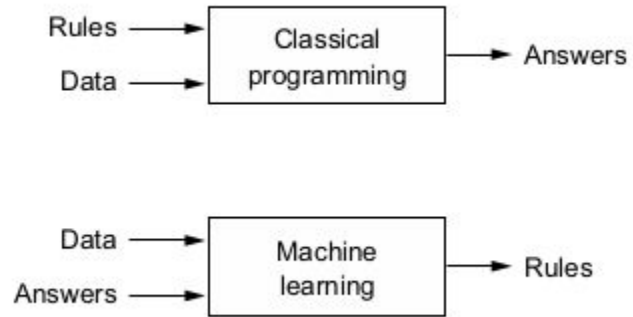


Figure 1.1 Artificial intelligence, machine learning, and deep learning

Machine learning



**Figure 1.2 Machine learning:
a new programming paradigm**

Deep learning

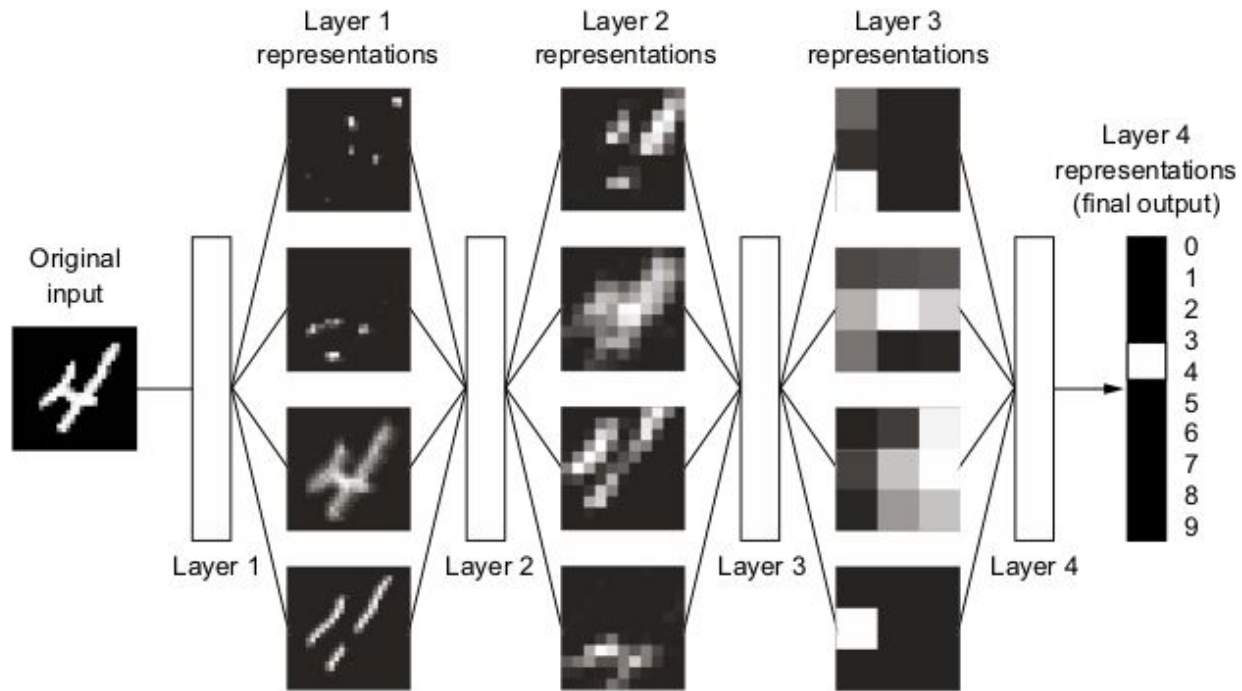


Figure 1.6 Data representations learned by a digit-classification model

How deep learning works

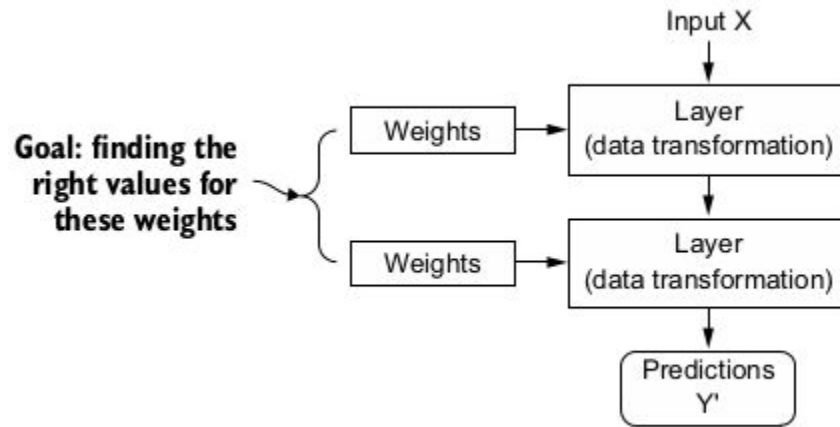
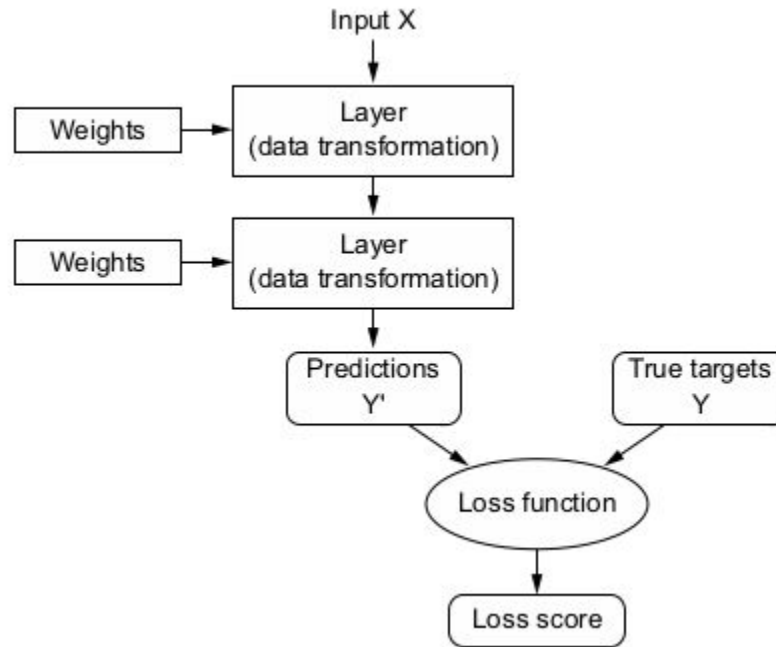
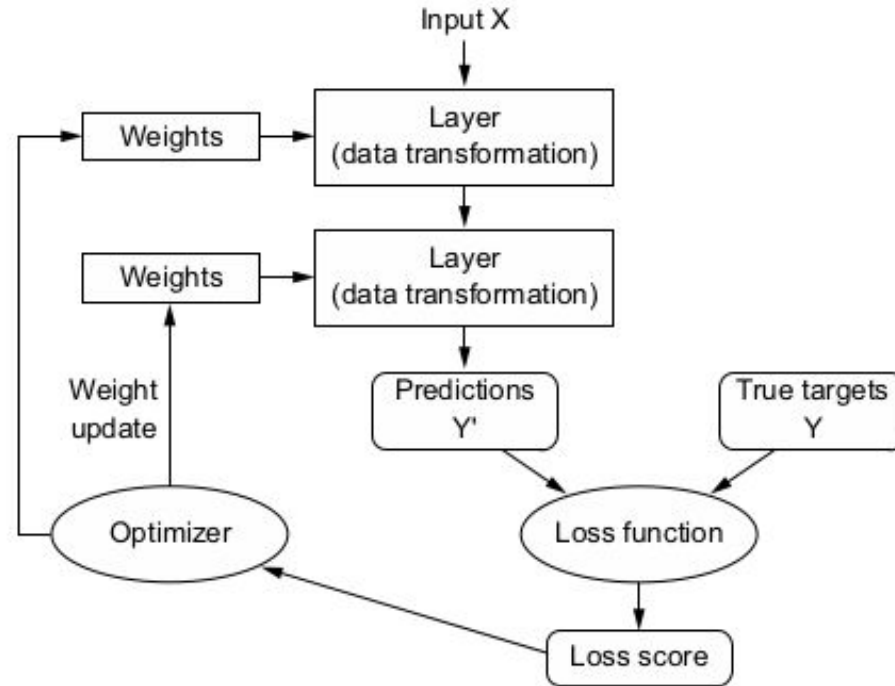


Figure 1.7 A neural network is parameterized by its weights.

How deep learning works



How deep learning works



What deep learning has achieved so far

- ◎ Near-human-level image classification
- ◎ Near-human-level speech transcription
- ◎ Near-human-level handwriting transcription
- ◎ Dramatically improved machine translation
- ◎ Dramatically improved text-to-speech conversion
- ◎ Digital assistants such as Google Assistant and Amazon Alexa
- ◎ Near-human-level autonomous driving
- ◎ Improved ad targeting, as used by Google, Baidu, or Bing
- ◎ Improved search results on the web
- Ability to answer natural language questions
- Superhuman Go playing

A decorative network diagram in the top-left corner, featuring a complex web of interconnected nodes and lines, with some nodes highlighted in blue and others in grey.

2.

A first look at a neural network

The “Hello World” of deep learning

- ◎ MNIST dataset, grayscale images of handwritten digits (28×28 pixels)
- ◎ 60,000 training images, plus 10,000 test images
- ◎ Goal: to classify images of handwritten digits into their 10 categories (0 through 9).
- ◎ In machine learning,
 - A category in a classification problem is called a **class**.
 - Data points are called **samples**.
 - The class associated with a specific sample is called a **label**.

◎



Workflow

1. First, we'll feed the neural network the training data, `train_images` and `train_labels`.
2. The network will then learn to associate images and labels.
3. Finally, we'll ask the network to produce predictions for `test_images`, and we'll verify whether these predictions match the labels from `test_labels`.



Layer in neural network

- ◎ **Layers** extract representations out of the data fed into them—hopefully, representations that are more meaningful for the problem at hand.
- ◎ Most of deep learning consists of chaining together simple layers that will implement a form of progressive *data distillation*.
- ◎ A deep learning model is like a sieve for data processing, made of a succession of increasingly refined data filters—the layers.

Compilation step

- ⦿ An **optimizer**: The mechanism through which the model will update itself based on the training data it sees, so as to improve its performance.
- ⦿ A **loss function**: How the model will be able to measure its performance on the training data, and thus how it will be able to steer itself in the right direction.
- ⦿ **Metrics** to monitor during training and testing: Here, we'll only care about accuracy (the fraction of the images that were correctly classified).



3.

Data representations for neural networks

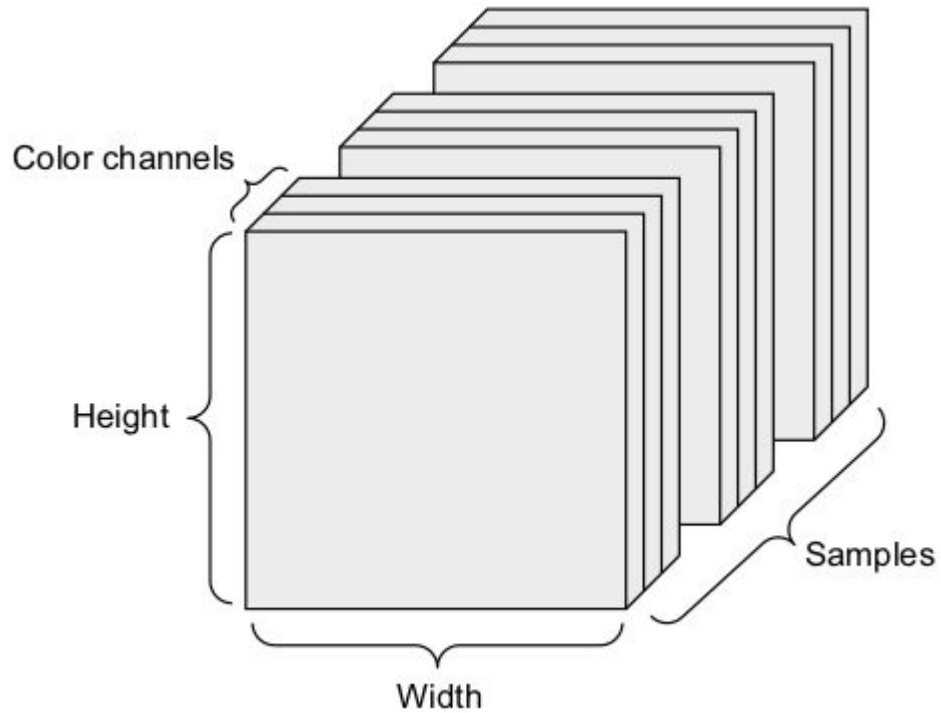
Data representations for neural networks

- ⊙ Scalars (rank-0 tensors)
- ⊙ Vectors (rank-1 tensors)
- ⊙ Matrices (rank-2 tensors)
- ⊙ Rank-3 and higher-rank tensors

Key attributes

- ⦿ Number of axes or rank (`ndim`)
- ⦿ Shape (`shape`) tuple of integers that describes how many dimensions the tensor has along each axis.
- ⦿ Data type (`dtype`), `float16`, `float32`, `float64`, `uint8`.

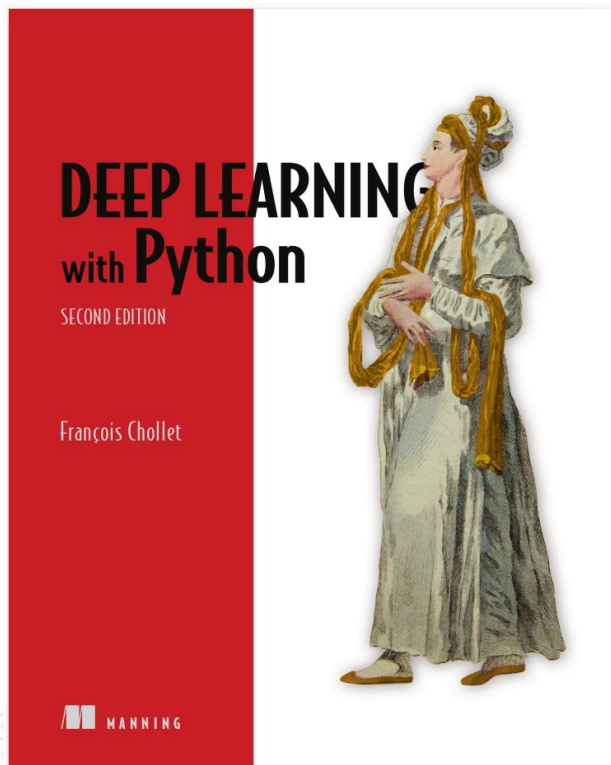
Image data



A decorative network diagram in the top-left corner, featuring a complex web of interconnected nodes and lines. The nodes are represented by small circles, some of which are larger and have concentric circles, suggesting a hierarchical or multi-layered structure. The lines are thin and gray, connecting the nodes in a non-linear fashion.

4. **The book**

Deep Learning with Python, 2nd Ed. by Francois Chollet



© Chapter 2



Thanks!

Any questions?

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