

Chapter 12

Applications

In this chapter, we describe how to use deep learning to solve applications in computer vision, speech recognition, natural language processing, and other application areas of commercial interest. We begin by discussing the large scale neural network implementations required for most serious AI applications. Next, we review several specific application areas that deep learning has been used to solve. While one goal of deep learning is to design algorithms that are capable of solving a broad variety of tasks, so far some degree of specialization is needed. For example, vision tasks require processing a large number of input features (pixels) per example. Language tasks require modeling a large number of possible values (words in the vocabulary) per input feature.

12.1 Large-Scale Deep Learning

Deep learning is based on the philosophy of connectionism: while an individual biological neuron or an individual feature in a machine learning model is not intelligent, a large population of these neurons or features acting together can exhibit intelligent behavior. It truly is important to emphasize the fact that the number of neurons must be *large*. One of the key factors responsible for the improvement in neural network's accuracy and the improvement of the complexity of tasks they can solve between the 1980s and today is the dramatic increase in the size of the networks we use. As we saw in section 1.2.3, network sizes have grown exponentially for the past three decades, yet artificial neural networks are only as large as the nervous systems of insects.

Because the size of neural networks is of paramount importance, deep learning