CHAPTER 4

Machine Learning vs. Deep Learning

In the previous chapters, we learned that artificial intelligence involves the phenomenon of thinking machines. Machine learning is the technique of helping a machine to think so it is able to perform actions on its own. We also learned that deep learning is a type of machine learning that uses neural networks to help a machine learn. These neural networks are modeled after the human brain.

That said, you now may be wondering: Why would we compare machine learning and deep learning when they are not independent, but rather the latter is a subset of the former?

Well, as you've seen, traditional machine learning has several methods. Deep learning is one such method that is much more advanced in the way it works, and thus the procedure and results may vary. In this short chapter, we will discuss the differences between traditional machine learning and deep learning, which will help us understand when to use each method, as per our requirements.

Factors Used When Comparing Machine Learning and Deep Learning

First of all, we need to understand that there are six characteristics based on which we will be comparing machine learning and deep learning. Of course, these aren't necessarily the only factors, as there are several other factors that differentiate one from the other. However, for the sake of getting a clear idea of how the two differ from each other, we will take into consideration these six aspects. Let's go through them briefly and see what they are.

- **Quantity of data required:** This refers to the amount of data that is needed for the process of learning. In some cases, we may have massive amounts of data that we have collected from various sources, and that we desire to use for our analysis. In other cases, we may have slightly less data with which we will need to perform our analysis.

- **Accuracy:** The main objective of every machine learning and deep learning problem is to obtain the highest accuracy, while ensuring that the model has not reached a state of overfitting. That said, our results can vary depending on the method, algorithm, technique, and data that we use. One method may give us higher accuracy, while another method may not.

- **Computational power:** The machines that are being trained require plenty of computational power in order to effectively perform their task. Earlier, when machine learning had just been invented, machines were slower and had less capacity. This resulted in inefficient outcomes. Nowadays, however, machines

have improved. It is thus possible to carry out our computations with tremendous computational power.

- **Cognitive ability:** This refers to the ability of the machine to understand its inaccuracies and sort out the issue on its own. If a machine does not have this ability, it will not be able to make corrections to its parameters and/or structure, and a programmer will have to step in and do it for the machine.

- **Hardware requirements:** This refers to the type of hardware equipment needed by the algorithms to carry out their respective operations. This mainly depends on how advanced the program is, and on what the outcome is expected to be.

- **Time taken:** This refers to the amount of time taken, first to train the model, and then to validate it. This can vary according to the different parameters and algorithms used. By modifying them, we can either increase or decrease the amount of time taken to train and test the model.

Now that we are aware of the various factors that we will be considering to compare our models and what exactly each factor refers to, we can move on to exploring the differences between machine learning and deep learning.

Differentiating Between Regular Machine Learning and Deep Learning

Before we begin, we must remember that these are not necessarily the only factors involved in differentiating between machine learning and deep learning, especially considering that the entire process is a highly advanced area of technology, which means that there are many intricacies involved. However, we will keep our comparison simple but informative, so as to easily comprehend the differences between the two processes. Thus, taking into consideration the six factors mentioned earlier, we will now see how machine learning and deep learning vary from each other.

Quantity of Data Required

In general, machine learning requires plenty of data for the machine to successfully train itself. However, in traditional machine learning, we do not need to have too much data. We just need enough to enable the machine to process, learn, and act. On the other hand, deep learning needs larger amounts of data. This is to ensure that the machine has enough information to develop inferences on its own, without any external aid. See Figure 4-1.
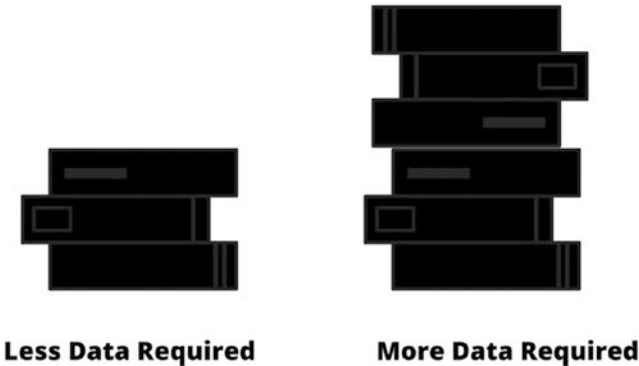

Figure 4-1. *Comparison of data requirements*

Accuracy

Accuracy, as you likely already understand, is the measure of how correct or precise the machine is when coming up with a solution. Although both methods give results that are quite precise, as you can see in Figure 4-2, regular machine learning is relatively less accurate, since it uses a smaller amount of data from which to learn and make inferences. Deep learning is much more accurate due to the large amount of data that it uses to learn and make inferences.
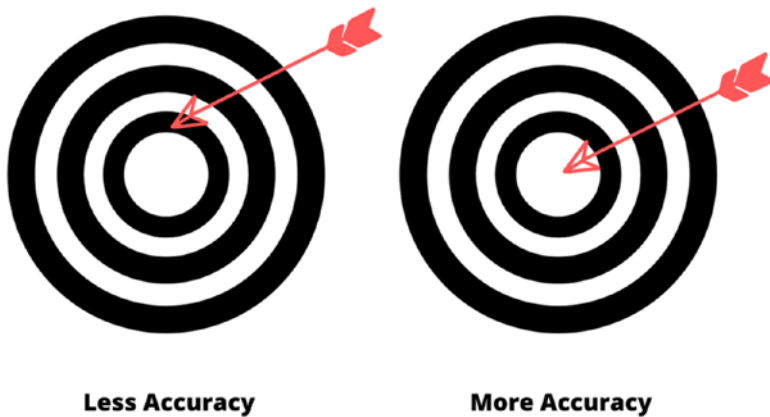

Less Accuracy   **More Accuracy**

Figure 4-2. *Comparison of accuracy*

Computational Power

Both machine learning and deep learning require a lot of computational power in order to train their models with the data given to them. However, the amount of power required by regular machine learning programs is comparatively less, mainly due to the fact that it uses less data for its computations. Deep learning requires more power to analyze its data and train its model. See Figure 4-3.
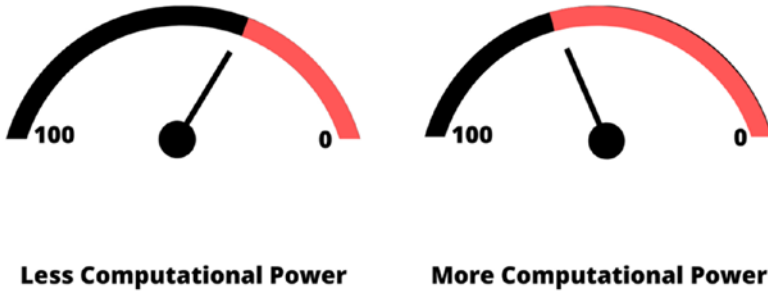
Figure 4-3. *Comparison of computational power*

Cognitive Ability

One of the most important differences between machine learning and deep learning is that their cognitive abilities vary. Machine learning models have a lower cognitive ability because if they happen to make an inaccurate prediction, external assistance (in this case, a programmer) is required to make the necessary changes and then retrain the model. Deep learning models, however, have a higher cognitive ability because they can figure out inaccuracies and make the necessary changes on their own, without the need of a programmer. See Figure 4-4.
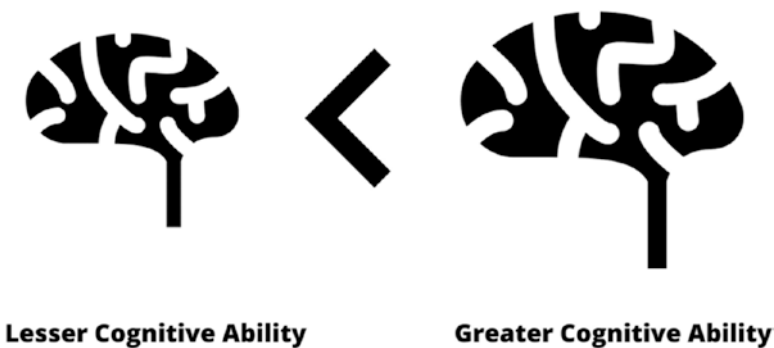

Figure 4-4. *Comparison of cognitive ability*

Hardware Requirements

Most traditional machine learning algorithms can run smoothly on low-end systems. They do not depend too much on sophisticated machinery to carry out their processes. Deep learning algorithms, on the other hand, depend heavily on the hardware that is used because they need GPUs to optimize their processes. Therefore, they would need high-end machines for their operations. See Figure 4-5.
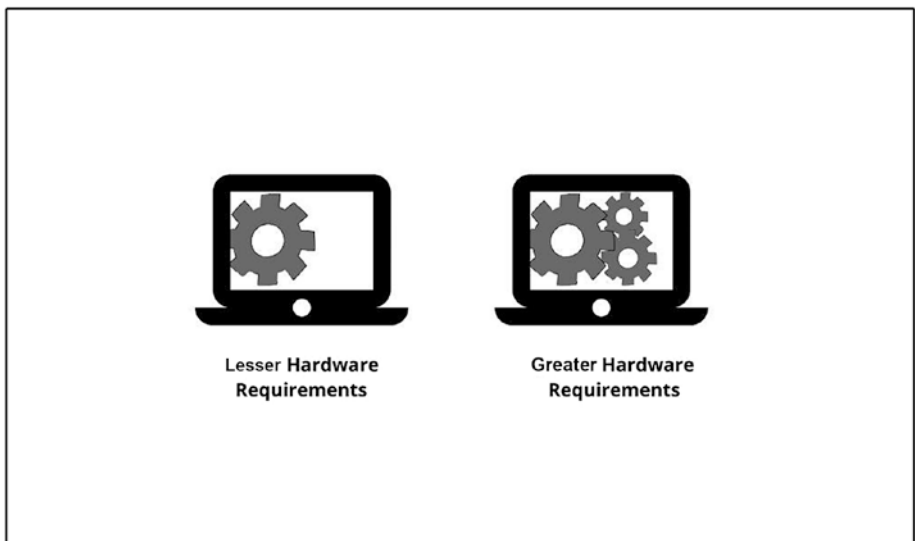

Figure 4-5. *Comparison of hardware requirements*

Time Taken

Although this may not be true in all cases, it is a generally known fact that machine learning models take less time to train, while deep learning models take a longer time. This occurs mainly because deep learning models consist of more parameters, which means that the machine has a lot more work to do with regard to learning from its data. Machine learning

models, however, don't have too many parameters, and so it is easier for the algorithm to compute.

When it comes to validation of the models, deep learning tends to be faster, whereas machine learning is slower. Once again, this differs from case to case. See Figure 4-6.
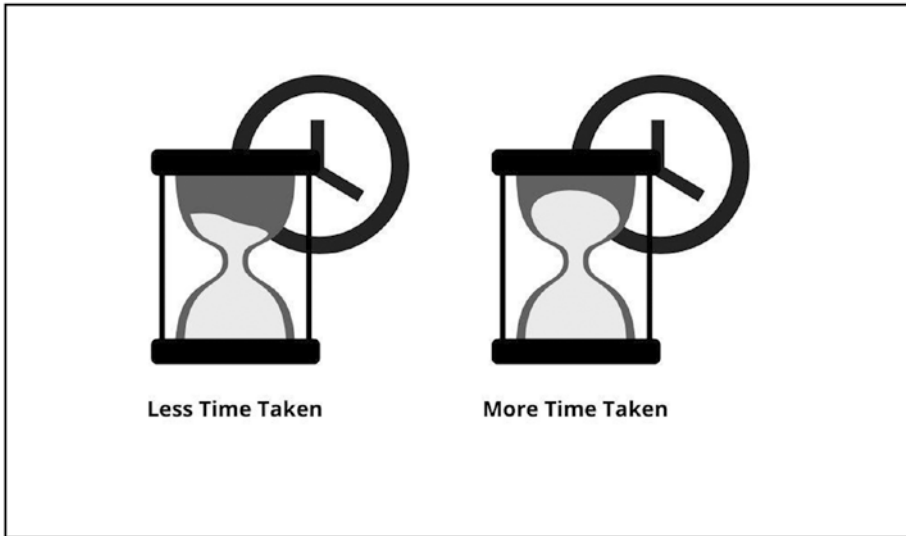

Figure 4-6. *Comparison of time taken*

Summary

We have seen six ways in which deep learning differs from machine learning. It is now easy to understand why many people consider both areas to be extremely important in the field of artificial intelligence. Depending on the kind of input and technology available, people can choose the type of machine learning method they want to employ.

We can now move on to the process involved in setting up the system to help it learn. This is where the programming part comes in. Machine learning requires programmers to use data science techniques, followed

by some specific machine learning algorithms, to enable the machine to think on its own. All this can be done within one single program.

We can use several programming languages to carry out our machine learning tasks, like Python, Java, C++, Julia, and R. However, since Python has emerged as one of the most popular machine learning programming languages so far, we shall be having a look at it over the next few chapters in the context of machine learning and deep learning.