Overview:
Deep Learning - Part I

What is Deep Learning?

- **Deep Learning is a specific subset of Machine Learning** that utilizes a computational technique called **Neural Networks**, in an attempt to replicate how biological intelligence processes information and makes decisions.

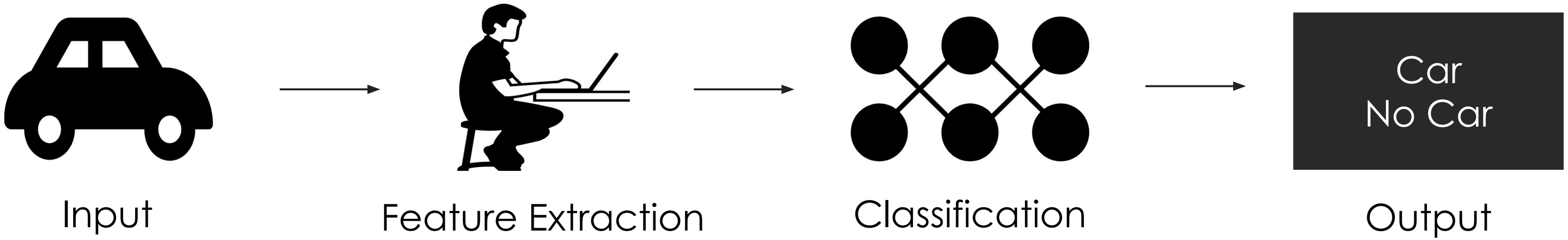
- As the name suggests, the ideas behind Neural Networks draw their inspiration from Neuroscience and other areas of biological research, and have already been around for many decades. However, it is only recently, **due to the rise in the volume of data** and the **increased computational resources** available to modern-day researchers, that the whole world has realized **the power and flexibility of Deep Learning**, and the true paradigm shift it represents in the evolution of computing.

- To understand the reasons for the above, we first need to gain an intuition for how Deep Learning does things differently from more traditional techniques in Machine Learning, and why that approach allows for a more autonomous form of data-driven decision-making.

Typical Machine Learning Workflow

- In a typical Machine Learning setting for predictive applications, the workflow would look something like the following diagram:

Machine Learning



- Let’s assume we have a classification system that aims to predict whether an image belongs to a car or not.

Typical Machine Learning Workflow

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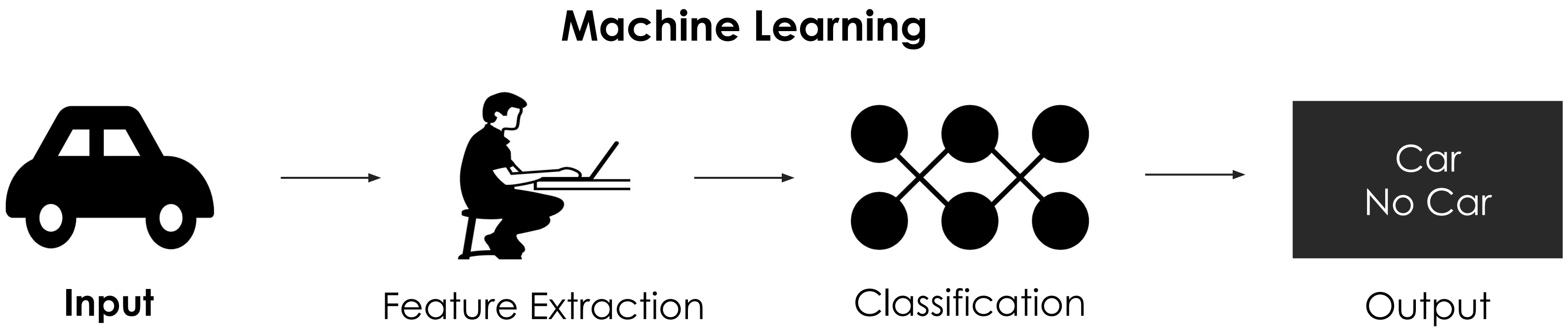

- In that case, **the input data to our model would be images of various objects**, from which we would expect some of the images to be those of cars.

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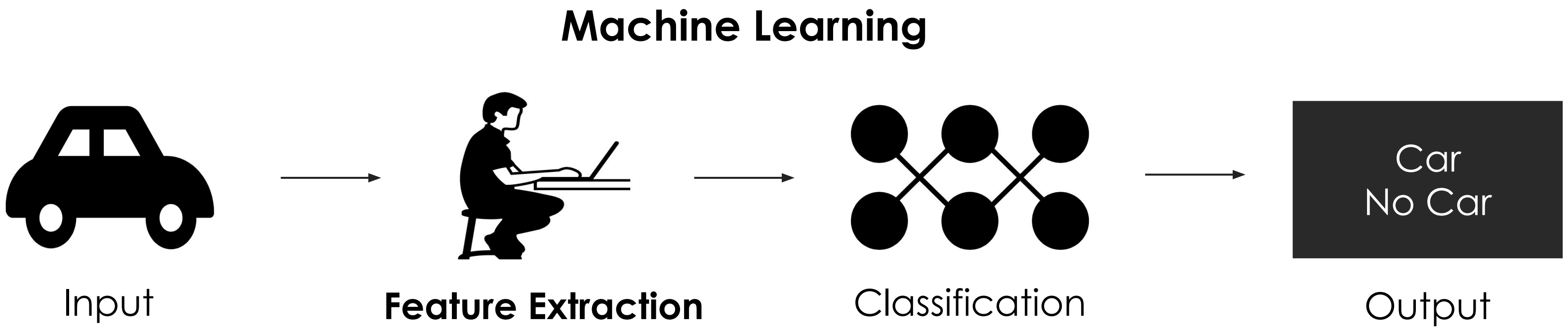

- In the usual Machine Learning workflow, we would feed in these images, **construct a set of features out of the image** (also called Feature Extraction), and provide these features of the image to our classification model.

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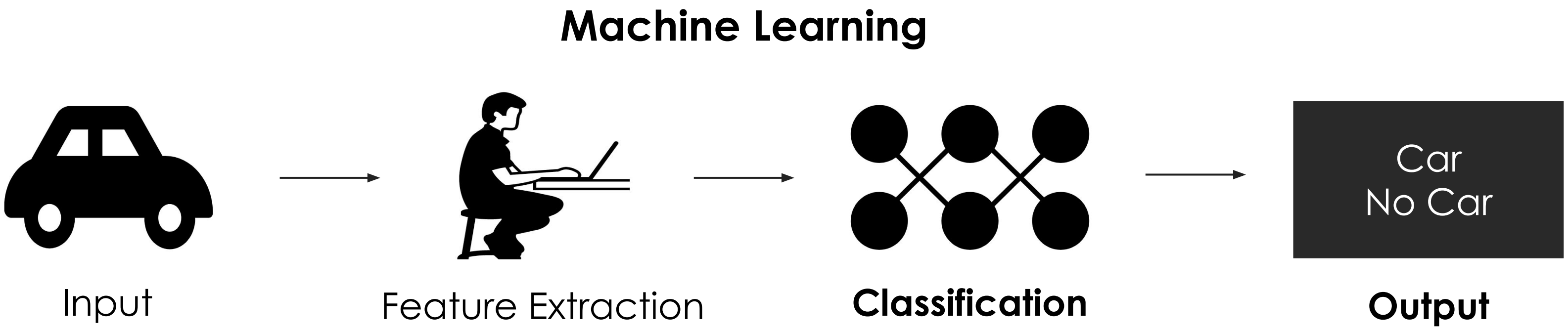

- Only after these features are provided to our classification model, will the model be able to make predictions and classify, **based on the features it was provided**, if the input image belongs to a car or not.

The Problem of Feature Extraction

- **The key point to note here is the process of feature extraction** which is part of the Machine Learning workflow.

- It is important to understand that in Machine Learning, the process of **feature extraction represents a bottleneck in the quality of the solution design.** The more important / relevant the features we can think of or create for the prediction problem, the better the model becomes. In other words, in Machine Learning, **the performance of the model is constrained by the quality of the feature set** we can manually & creatively extract from the data and provide to the algorithm.

- In many of the curated, tabular datasets we have worked with in Machine Learning, the columns of the table already provide us with most of the key features required for every instance, and only a small amount of feature engineering is required from there to get the final feature set for good performance.

The Problem of Feature Extraction

- **However, the problem quickly becomes apparent** when we start working with the **more unstructured data modalities** present in real-world problem statements, such as images, text, audio, video and graphs.

- In these cases, it becomes **difficult to manually extract the right set of features** from data and build machine learning models that can recognize the right patterns to create good mappings from input to output.

- This is a core problem that statistical Machine Learning methods have historically struggled with - their need for manual / handcrafted Feature Extraction techniques, and this is one of the main reasons it was difficult to achieve good predictive performance on unstructured data before the rise of Deep Learning.

- In the next deck, we will see how Deep Learning solves this problem of Feature Extraction, and why this has allowed it to achieve generalized levels of high performance on many types of unstructured data.

Summary

So in order to summarize:

- **Deep Learning** is a specific paradigm of Machine Learning that utilizes **Neural Networks** to replicate how biological intelligence processes information and makes decisions.

- The issue faced by traditional Machine Learning algorithms is that **their performance is reliant on manual / handcrafted feature engineering techniques** to extract the right features from instances for good predictive power. **This approach does not scale well** with the **increasing complexity** and **unstructured nature** of the data prevalent in the modern world, and that is one reason Machine Learning algorithms have not been very successful at making predictions on images, text, audio and other unstructured data types.

- One of the reasons for Deep Learning's rise in prominence is that it overcomes this problem in an elegant manner, and we will see how it accomplishes this in the next slide deck.

Great Learning

Happy Learning !