EDITORIAL

Challenges and goals across machine learning

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ABSTRACT

Machine learning is about designing algorithms that automatically extract valuable information from data. The emphasis here is on "automatic", i.e., Machine learning is concerned about general-purpose methodologies that can be applied to many datasets, while producing something that is meaningful. There are three concepts that are at the core of machine learning: data, a model, and learning...

INTRODUCTION

Since machine learning is inherently data driven, data is at the core data of machine learning. The goal of machine learning is to design general-purpose methodologies to extract valuable patterns from data, ideally without much domain-specific expertise.

For example, given a large corpus of documents (e.g., books in many libraries), machine learning methods can be used to automatically find relevant topics that are shared across documents. To achieve this goal, we design models that are typically related to the process that generates data, similar to model the dataset we are given. For example, in a regression setting, the model would describe a function that maps inputs to real-valued outputs.

A model is said to learn from data if its performance on a given task improves after the data is taken into account.

The goal is to find good models that generalize well to yet unseen data, which we may care about in the future. Learning can be understood as a learning way to automatically find patterns and structure in data by optimizing the parameters of the model. While machine learning has seen many success stories, and software is readily available to design and train rich and flexible machine learning systems, we believe that the mathematical foundations of machine learning are important in order to understand fundamental principles upon which more complicated machine learning systems are built.

Understanding these principles can facilitate creating new machine learning solutions, understanding and debugging existing approaches, and learning about the inherent assumptions and limitations of the methodologies we are working with. A challenge we face regularly in machine learning is that concepts and words are slippery, and a particular component of the machine learning system can be abstracted to different mathematical concepts. For example, the word "algorithm" is used in at least two different senses in the context of machine learning. In the first sense, we use the phrase "machine learning algorithm" to mean a system that makes predictions based on input data.

We refer to these algorithms as predictors. In the second sense, predictor we use the exact same phrase "machine learning algorithm" to mean a system that adapts some internal parameters of the predictor so that it performs well on future unseen input data. Here we refer to this adaptation as training a system.

Image recognition is a well-known and widespread example of machine learning in the real world. It can identify an object as a digital image, based on the intensity of the pixels in black and white images or colour images. Real-world examples of image recognition: Label an x-ray as cancerous or not.

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