Chapter 3
Introduction to Machine Learning

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ABSTRACT

Machine learning refers to the changes in systems that perform tasks associated with artificial intelligence. This chapter presents introduction types and application of machine learning. This chapter also presents the basic concepts related to feature selection techniques such as filter, wrapper and hybrid methods and various machine learning techniques such as artificial neural network, Naive Bayes classifier, support vector machine, k-nearest-neighbor, decision trees, bagging, boosting, random subspace method, random forests, k-means clustering and deep learning. In the last the performance measure of the classifier is presented.

1. INTRODUCTION

Learning means to gain knowledge, or understanding of, or skill in, by study, instruction, or experience, and modification of a behavioral tendency by experience. Machine learning refers to the changes in systems that perform tasks associated with artificial intelligence. These tasks involve recognition, diagnosis, planning, robot control, prediction, etc. Machine Learning is coming into its own, with a growing recognition that machine learning plays a key role in a wide range of critical applications, such as data mining, natural language processing, image recognition, and expert systems. Machine learning provides potential solutions in all these domains. We need machine learning in the following reasons.

1. Some tasks cannot be defined well except by example; that is, we might be able to specify input/output pairs but not a concise relationship between inputs and desired outputs. We would like machines to be able to adjust their internal structure to produce correct outputs for a large number of sample inputs and thus suitably constrain their input/output function to approximate the relationship implicit in the examples.

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2. It is possible that hidden among large piles of data are important relationships and correlations. Machine learning methods can often be used to extract these relationships.
3. Human designers often produce machines that do not work as well as desired in the environments in which they are used. In fact, certain characteristics of the working environment might not be completely known at design time. Machine learning methods can be used for on-the-job improvement of existing machine designs.
4. The amount of knowledge available about certain tasks might be too large for explicit encoding by humans. Machines that learn this knowledge gradually might be able to capture more of it than humans would want to write down.
5. Environments change over time. Machines that can adapt to a changing environment would reduce the need for constant redesign.
6. New knowledge about tasks is constantly being discovered by humans.

2. TYPES OF MACHINE LEARNING

Machine learning algorithms are based on the desired outcome of the algorithm. Common algorithm types include:

- **Supervised Learning:** Where the algorithm generates a function that maps inputs to desired outputs. One standard formulation of the supervised learning task is the classification problem: the learner is required to learn (to approximate the behavior of a function which maps a vector into one of several classes by looking at several input-output examples of the function.
- **Unsupervised Learning:** Which models a set of inputs labeled examples are not available.
- **Semi-Supervised Learning:** Which combines both labeled and unlabeled examples to generate an appropriate function or classifier.
- **Reinforcement Learning:** Where the algorithm learns a policy of how to act given an observation of the world. Every action has some impact in the environment, and the environment provides feedback that guides the learning algorithm.
- **Transduction:** Similar to supervised learning, but does not explicitly construct a function, instead, tries to predict new outputs based on training inputs, training outputs, and new inputs.
- **Learning to Learn:** Where the algorithm learns its own inductive bias based on previous experience.

The performance and computational analysis of machine learning algorithms is a branch of statistics known as computational learning theory. Machine learning is about designing algorithms that allow a computer to learn. Learning is not necessarily involves consciousness but learning is a matter of finding statistical regularities or other patterns in the data. Thus, many machine learning algorithms will barely resemble how human might approach a learning task. However, learning algorithms can give insight into the relative difficulty of learning in different environments.