Chapter 1

Introduction

1.1 Definition

Any change in a system that allows it to perform better the second time on repetition of the same task or on another task drawn from the same population (Simon, 1983).

1.2 Paradigms

Depending on the amount and type of knowledge available to the system before the learning phase (system's a priori knowledge) we can distinguish several situations:

- The simplest form of learning is just assigning values to specified parameters. This is a situation when the system contains all the knowledge required for a particular type of tasks.
- Another rudimentary type of learning is storing data as it is. This is called *rote learning*. An example of this type of learning is filling a database.
- The process of *knowledge acquisition* in an expert system is a kind of learning task where some pre-defined structures (rules, frames etc.) are filled with data specified directly or indirectly by an expert. In this case only the structure of the knowledge is known.
- The system is given a set of examples (*training data*) and it is supposed to create a description of this set in terms of a particular language. The a priori knowledge of the system is the syntax of the allowed language (*syntactical bias*) and possibly some characteristics of the domain from which the examples are drawn (*domain knowledge* or *semantic bias*). This is a typical task for *Inductive learning* and is usually called *Concept learning* or *Learning from examples*.
- There are learning systems (e.g.*Neural networks*) which given no a priori knowledge can learn to react properly to the data. Neural networks actually use a kind of a pre-defined structure of the knowledge to be represented (a network of neuron-like elements), which however is very general and thus suitable for various kinds of knowledge.

As in human learning the process of machine learning is affected by the presence (or absence) of a teacher. In the *supervised learning* systems the teacher explicitly specifies the desired output (e.g. the class or the concept) when an example is presented to the system (i.e. the system uses pre-classified data). In the *reinforcement learning* systems the exact output is unknown, rather an estimate of its quality (positive or negative) is used to guide the

learning process. *Conceptual clustering* (category formation) and *Database discovery* are two instances of *Unsupervised learning*. The aim of such systems is to analyze data and classify them in categories or find some interesting regularities in the data without using pre-classified training examples.

Any change in the learning system can be seen as acquiring some kind of knowledge. So, depending on what the system learns we can distinguish:

- Learning to predict values of unknown function. This is often called *prediction* and is a task well known in statistics. If the function is binary, the task is called *classification*. For continuous-valued functions it is called *regression*.
- *Concept learning*. The systems acquires descriptions of concepts or classes of objects.
- *Explanation-based learning*. Using traces (explanations) of correct (or incorrect) performances the system learns rules for more efficient performance of unseen tasks.
- *Case-based (exemplar-based) learning*. The system memorizes cases (exemplars) of correctly classified data or correct performances and learns how to use them (e.g. by making analogies) to process unseen data.