Hybrid Methods in Machine Learning and Applications

This presentation summarizes results obtain in the research work performed within the Research Center in Informatics and Information Technology from the Faculty of Science, University "Lucian Blaga" of Sibiu, Romania.

Machine learning approaches are widely used in solving complex real problems involving classification and regression tasks, concept learning, image and voice recognition, robotics, etc. In this talk we focus on two machine learning methods: Support Vector Machines (SVMs) and reinforcement learning. Both methods are dependent on one or several parameters whose choice strongly influences the performance of the methods. Therefore the need arises to find techniques for the automatic optimization of the parameters. We present hybrid methods based on nature inspired algorithms and evolutionary algorithms for optimization of parameters in SVM and reinforcement learning.

SVMs are supervised learning methods used for solving classification and regression tasks. Medicine, biology, chemistry, environmental sciences, weather forecasting and financial forecasting are only a few fields requiring these kinds of tasks. Considering a set of data defined by a set of features and a label (target value), the aim of SVMs is to provide, based on a training data set, a model which predicts the target value of data instances which are given only by their features. The accuracy of the model is established by using a testing data set. If the data is linearly separable the model supplies an optimal classification hyperplane with maximal margin. In the non-linear case, the data are mapped into a higher dimensional Hilbert space where they become linearly separable. The classifier (decision function) is obtained in terms of a kernel function without having to know the mapping function. There are several simple kernel functions that can be used, all of them depending on one or more parameters. The accuracy of the model is influenced by the choice of these parameters, but a more difficult problem we face is the strong dependence of the model on the data. For instance, one model could act well on data from the medical field, having a bad behavior on the same data belonging to the economical field. Therefore there is not a standard method for the choice of the model parameters. On the other hand it was proved that single kernel functions can not accurately model the real complex problems.

One of our aims is to introduce an approach for building optimal SVM complex kernels. The choice of the parameters is made using different genetic algorithms and wasp algorithms. We implemented and validated the proposed approach on many data sets. A comparison of the

accuracy obtained by using different genetic algorithms was also performed. The previously presented results were exploited for automate watermark identification from host images affected by noise.

Reinforcement learning is dedicated to learn optimal choices based on a system of rewards or penalties. Reinforcement learning was successfully used in solving tasks such as learning to control a mobile robot, learning to drive an autonomous vehicle, learning to play games, designing multi-agent systems, etc. Learning automata are based on learning algorithms named reinforcement schemes. These schemes must allow the automata to learn from their previous actions and to adapt to changes in their environment. Absolutely expedient learning schemes represent the unique class of reinforcement schemes for which necessary and sufficient design conditions are available.

We introduce a general two-parameter dependent absolute expedient reinforcement scheme and propose an approach based on a breeder genetic algorithm for parameters' optimization. We automatically found the optimal values for the learning parameters of three reinforcement schemes, derived from our general one, in order to reach the best performance with respect to the number of iterations in the learning process.

An application of reinforcement schemes to the design of an autonomous vehicle is also presented.