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Cooperative Machine Learning Method

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Abstract— Cooperative learning refers to an approach where one or more team of learners work together towards reaching a better knowledge or understanding of a specified task. The purpose of this paper is to use this approach to describe a proposal for designing and building a cooperative machine learning system (Multi-Learning system) that contains two or more machine learners that cooperate together.

The objective of the proposal in this paper is to improve the effectiveness of the machine learning systems.

Keywords- Cooperative Learning; Machine Learning; inductive learning; Multi-Learning system; Knowledge base; Artificial Intelligence.

I. INTRODUCTION

Learning is a very general term describing the way in which people increase their knowledge and improve their skills. Learning also can be defined as the change in a system that allows it to perform better in the second time on repetition of the same task or on another task drawn from a similar area. In education, cooperative learning refers to an approach where one or more team of learners work together towards reaching a better knowledge or understanding of a specified task. The team members are required to share their knowledge and to assist one another in completing a task.

Machine learning (ML) is a simulation for the human being learning system. It has been studied extensively, but most of the studies depended on a single-agent ML system. Recently ML has received attention in studying ML by combining two or more learning systems together in one multi-agent learning system.

Cooperative learning process can be simulated by a computer system to provide computers and machine learning systems with the ability to be more knowledgeable and smart in doing its tasks. This approach can be used to build a cooperative machine learning system or Multi-Learning system that contains two or more machine learners that cooperate together.

In this paper I propose a method to build a Multi-learning system. This method allows multiple machine learners to learn together, thus utilizing one another's strengths and decrease individual learner weaknesses. The proposed method describe an idea for a project to build a cooperative inductive learning team (CILT) multi-agent learning system. This system can consists two or more learning systems, which induce rules from training examples. By cooperating, the individual results of the learning systems are improved and a team K.B. that contains the best team results is created.

In section 2, we give an overview about the machine learning field and described the single-agent learning system. In section 3, we described the proposed multi-agent learning method. In section 4, we discussed some issues and problems that may occur with this method, and give some suggestions to solve these problems. Finally in section 5, a conclusion is given.

II. SINGLE AGENT LEARNING SYSTEM

A general model of machine learning is given in figure 1. The input to this model is obtained from a teacher, from reference material, or from the environment at large. The learning element receives and processes this input according to various strategies, to make improvements in the knowledge base (K.B.). The performance element uses the K.B. to perform its task. In order to evaluate how well the system has learned, the same input is presented to an idealized system (a trained person or special computer program) that should produce what is deemed to be the correct output. Both outputs are then fed into a feedback element to identify any differences and determine what additional input the learning element needs in order to produce corrected output. In addition, a data generator element can be added to the learning system to help in generating new examples to the learning element in order to improve the performance of learning.

A. Some factors that affecting the design of the learning systems:

1. Environment: Kind of information (level and quality) supplied to the system by the environment is the

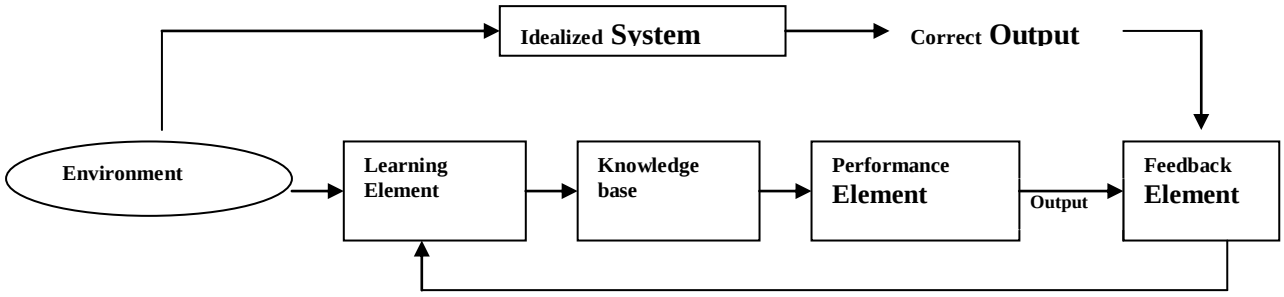

Figure 1: Simple model of learning.

most important factor. Level means the degree of generality. The learning element has to modify this level to be accepted by the performance element. The quality of information can have an effect on the difficulty of the learning task; for example, contradictory and analogies of data in rote-learning.

2. Knowledge base: The form and content of the K.B. affecting the design of the learning systems. In any AI system it is important to have a representation in which the relevant knowledge can be easily expressed, modified, extendable and easily to infer results.
3. Performance element: It is the focus of the whole learning system, since it is the job that the learning element is trying to improve. Some factors affecting the performance elements are: First, complexity, i.e. complex tasks requires more knowledge than simple task. Second, feedback; all learning systems must have some way of evaluating the hypothesis that have been proposed by the learning element. Third, transparency; for the learning element to assign credit or blame to individual rules in the K.B., it is useful for the learning element to have access to the internal actions of the performance element.

B. Learning methods:

Several learning methods are available; here we describe some of them:

1 – Learning from examples: is the best understood method of learning. One way to teach a system how to perform a task is to present it with examples of how it should behave. The system must then generalize these examples to find higher level rules that can be applied to guide the performance element. Learning from examples is also known as "learning by induction", or "inductive learning".

2 – Rote learning: in which the environment provides information exactly at the level of the performance task. The learning system does not need to do any processing to understand or interpret the information supplied by the environment.

3- Learning from instruction (learning by being told): in which the information provided by the environment is too abstract or general, and thus the learning element must hypothesize the missing details.

4 – Learning by analogy: in which the information provided by the environment is relevant only to an analogues performance task and, thus the learning system must discover the analogy and, hypothesize analogous rules for its present performance task.

5 – Learning from observation and discovery: this is a general form of inductive learning that includes discovery systems. This form of learning requires the learner to perform more inference than other methods. The learner is not provided with a set of instances of a particular concept.

III. Proposed Method (Multi-Learning system):

Cooperative learning process can be simulated by a computer system to provide computers and machine learning systems with the ability to be more knowledgeable and smart in doing its tasks. This approach can be used to build a cooperative machine learning system or Multi-Learning system that contains two or more machine learners that cooperate together.

In this paper I propose a method to build a Multi-learning system. This method allows multiple machine learners to learn together, thus utilizing one another's strengths and decrease individual learner weaknesses. The proposed method describes an idea for a project to build a cooperative inductive learning team (CILT) multi-agent learning system. This system can consist of two or more learning systems, which induce rules from training examples. By cooperating, the individual results of the learning systems are improved and a team K.B. that contains the best team results is created.

A. CILT learner architecture:

Each learner in the system contains the components shown above in figure 1, which illustrate the single agent learning system. These components are: the environment, learning element, K.B., performance element, feedback element, and a data generator element which can be added to help in generating new examples to the learning element in order to improve the performance of learning.

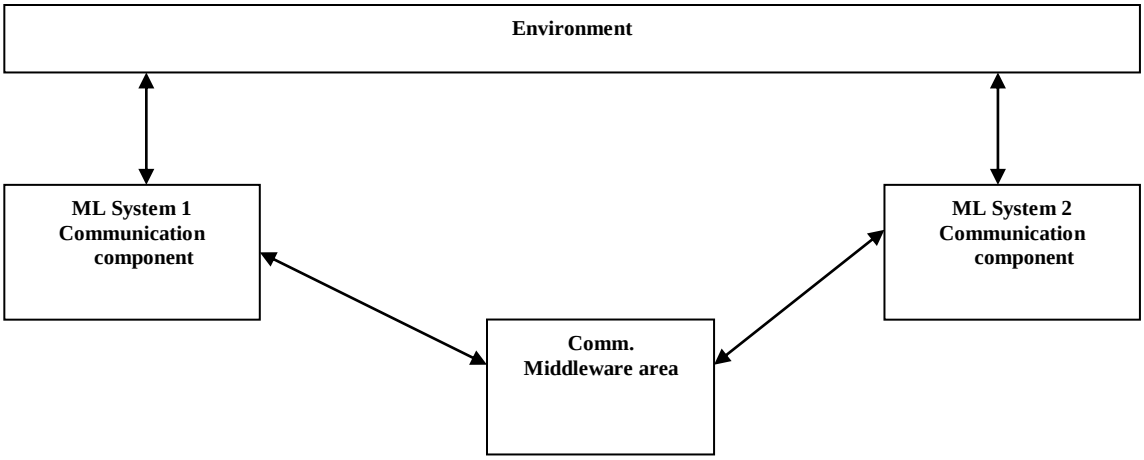

Figure 2: Multi-agent learning system

For the learner agent to communicate with another learner agent, a communication component can be added to the agent components. This component contains the K.B. of the learner with a query language that enables the learner to queries the K.B. of another learner. The other learner submits its knowledge, in a report, for use by the first learner, figure 2 below.

B. Learning Process:

The learning process consists two phases: the individual learning phase and the cooperative learning phase.

Individual learning phase: it involves single agent learning process. Each learner forms an individual set of rules that is placed in its individual K.B. When the individual learning process is completed, the learner places the results, in the form of rules and quality measures, in the individual K.B. The K.B. may be queried by the environment or by other agents.

Cooperative multi-agent learning phase: It is controlled by the performance element. During the cooperative learning, a learner queries the knowledge bases of one or more of the other team members. Each of these learners supplies the querying learner with a report that contains its current knowledge, in a form of rules and quality measures. In this way, a learner can modify its rules with high quality rules from other learners.

The data generator is supplied with a list of the high quality rules obtained from others. Each rule is used to generate a new set of training examples. The learner re-iterates the single –agent learning phase. After each iteration, the individual K.B. is modified by the high quality results of the single-agent learning. This process continues until no new high quality rules can be identified.

Finally, the individual rule sets are used into a team knowledge bases. The final individual and team knowledge bases are evaluated against the validation data set. The results of these evaluations are placed in the knowledge bases.

IV. Discussion

Several issues need to be discussed and studied in this proposed method; here are some of these issues:

1 – Method of interaction (coordination) between the agents: First an interaction protocol (algorithm) is needed to transfer such an advice between agents. Second, the load-balancing and band-width management problem, which need to be studied and implemented. One of the methods which can be used to solve these problems is to implement a middleware area between the agents, with suitable protocols to enable communication and coordination between agents.

2 – Other problems are" (How) can several different, heterogeneous, Learning Agents improve their performance by exchanging information during their own learning process?" For this we need to study the types and effects of exchanging information during the learning process. One method which can be used for information exchange during the learning process is based on exchanging advices among learners.

3 – Existing learning algorithms have been developed for single agents learning. Distributing the learning process among several learning agents require extensive modification for existing algorithms, or completely developing new algorithms. In addition performance of these new algorithms needs to be studied.

4 – Online learning methods is needed: On-line (or incremental) learning algorithms are needed to compute new hypotheses incrementally as soon as a new training example becomes available. One method is to use incremental learning algorithms, such as neural networks algorithms.

5 - Other issue is how to combine a new agent to an already existing multi-agent system. A new agent begins with a blank

state, as it has not yet had an opportunity to learn about its environment. However, a new agent may not need to find out everything about the environment for itself; it may well be possible to benefit from the accumulated learning of the existing experienced agents. One suggested method is to enforce a completely cooperative scenario for new agents to follow.

V. CONCLUSION

ML is a simulation for the human being learning system. In human being learning system, cooperative learning gives better results than single learning process. This process will improve the knowledge of each person by gaining more accurate and new knowledge. If this process is simulated in the ML systems, it will also give better results in the learning process for the learners in a multi-agent learning system.

In addition, ML is of great significance to several fields concerned with understanding intelligence. So any progress in ML area will improve these fields.

As we saw in the analysis section, there are several issues need to be studied and investigated deeply. We can choose one or more issues and study it in more detail. For examples: we can choose to modify some single agent algorithms to be used in a multi-agent environment; or we can build procedures or polices for combining new agents in the system.

Finally, Comparing the Multi-agent learning system with the single agent learning system, we can say that the Multi-agent system will improve the effectiveness of the Ml systems. In addition, multi-agent learning system is a recent and new topic in the machine learning field, and this field needs to be investigated deeply.

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