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Complex Behavior Using Classifier System

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Abstract:

Intelligent robots should be able to use sensors information to learn how to behave in a changing environment. As environmental complexity grows, the learning task becomes more and more difficult. This problem is faced by using an architecture based on learning classifier systems and on the structural properties of animals behavioral organization. Our proposed system used a fast GBML system called NEBOLE system to learn simulated robot to adopt a complex behavior which is combined from two or more basic behavior using a kind of architectures called Monolithic architecture. Our system adopt Rat-Cat-Dog problem as a complex behavior to be learned.

Keywords **—Genetic Programming, Reinforcement Learning, Learn Classifier System.**

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I. INTRODUCTION

It can be said that the mechanism of learning and the complex balance between what is learned and what is genetically determined, are the main concern of behavioral sciences. A similar situation arises in autonomous robotics, where a major problem is in deciding what should explicitly designed and what should be left for the robot to learn from experience. Because it may be very difficult, if not impossible, or a human designer to incorporate enough world knowledge into an agent from the very beginning, we believe that machine learning techniques will play a central role in the development of robotics agents. Agent reach a high performance level only if they are capable of extracting useful information from their experience from the history of their interaction with the environment. However the development of interesting behavior is not merely a matter of agent self_organization, because it doesn't use any specific feedback information to implement a learning process[2].

Behavior based robotics claims to provide better and perhaps the only possible way to develop intelligent systems.

Nature has produced such adaptability by means of evolution. Naturel systems have genetically learned to adapt, i.e. to increase likelihood to survive and to have more offspring . This evolutionary process has finally led to a flexible way of adaptation, and to cognitive abilities also to neural learning,. We will be able to understand the emergence of cognitive skills only when we can reproduce these adaptation processes.For this reason we consider genetic _based learning as a powerful and plausible way to develop intelligent systems.

To increase the chances of a species to survive, the approach we present in this paper is considered to reflect the basic mechanisms and to produce the kind of adaptability necessary for flexible robot intelligence and robust [3].

II. GENETIC BASED MACHINE LEARNING (GBML)

GBML has received growing consideration across a variety of fields. In this section we will introduce the general field of genetic based machine learning. Genetic based machine learning considers any system that uses some abstract adaptation of Darwinian evolutionary theory and terms of genetic algorithm, in its learning.

A genetic algorithm is a search algorithm often used in its own(e. g. for function optimization) but also as a search engine inside another system. The system that this paper canters on has become known as classifier system[1].
Classifier system is the most common GBML architecture . Classifier system can be used as a universal programming language and are therefore computationally complete. In this sense they are equivalent to other artificial intelligence systems such are connectionist networks and production systems.

Using reinforcement learning scheme is the standard approach in classifier systems. Reinforcement learning is learning what to do. How to map situations to actions so as to maximize numerical reward signal. Reinforcement learning does not tell the system explicitly what is the right action to take, but instead the system must discover which actions are the most rewarding in situations by trying them. So reinforcement learning system face a problem of how to divide their resources between exploring an environment and trying new things and exploiting their knowledge of the environment from that which has been learnt about things previously tried.

Reinforcement learning algorithms used a defined environment where certain environmental payoff and systems learn to choose actions that obtain maximum payoff. In contrast in supervised learning algorithms the system is explicitly told its actions are right or wrong, and the system updates its knowledge directed by the teaching value.

III. PROPOSED LEARNING SYSTEM

Our system Rat_Cat_Dog adopt behavior which is similar to the behavior as the animal can Rat, Cat, Dog . The structure of behavior is the problem of designing network. Our system used two types of behavior chasing and escaping to be learned, by chasing we mean following and trying to catch a still or moving object with given features. Our interesting problem a Cat following and trying to catch a still or moving Rat, while by escaping behavior we mean moving as far as possible from an object with given features. In our system the cat will move as far as possible when dogs sound heard. The combination used in our system is suppression which is a simple limit case of combination in which two lower level of output are combined by letting one of two be the final response. Cat follow Rat while ready to reach its lair and still their until dogs sound disappear.

A. Environmental settingsT

Our system was developed to meet increasing needs for systems capable of efficient learning of different environments. Our environment will have the following characteristics:-
The environment will be a two dimensional grid of size 32*32 cell. This limitations of environmental size will be more realistic in dealing with environments that have boarders surrounding it, to limit the movement inside the board.
We will use three kinds of objects in the environment Rat, Cat, and Lair. Lair has a constant position in the environment, while the Rat is still or moving since it has a constant or variable position in the environment at each time. Cat are the artificial creature that we want to learn the double behaviour and last the Dog is not appear as an object in our environment but it appears now and their at random time intervals only heard as a sound and it is always supposed to be a far enough since Cat has always the time to hide in the Lair.

The simulated Cat can also detect the difference between a close Rat and a distance Rat (the same is true for the Lair).The distinction between far and close was necessary because simulated Cat had to learn two different responses within the hiding behavior.

- When the Lair is far approach it.
- When the Lair is close do not move the Cat is into the Lair.

B. System target behavior

The simulated Cat should learn the following three behavior patterns:
-Chasing behavior: since simulated Cat likes to chase the Rat.
- Escaping behavior: simulated Cat occasionally hears the sound of Dog, its main goal then becomes to reach the Lair as soon as possible and to stay their until the Dog goes away (sound disappear).
Global behavior : a major problem for the learning Cat is not only to learn single behavior, but also to coordinate them. Then the resulting global behavior should be as flows:
The simulated Cat chases the Rat when it happens to hear a Dog, it suddenly gives up chasing, runs to the Lair, and stay their until the Dog is goes away. In these simulation the Cat can hear but cannot see. The Dog , therefore to avoid conflict situations like having to Dog between the Rat and the Lai, we make the implicit assumption that the Cat can hear the Dog when the Dog is still very far away. So that the Cat always has the time to reach the Lair before the Dog enters the computer environment.

C. System learning architecture

Our learning architecture used to learn simulated Cat the double behavior called monolithic architecture. In this type of architecture the learning system is implemented as a single low level parallel learning classifier system, called "LCS_ global".
Two behaviors learned using on classifier system. This architecture differs from the switch architecture in which the learning system is implemented as set of three classifier systems organized in a hierarchy : two classifier system learn the basic behavior (chasing and escaping) while one learn to switch between the two basic behavior.

D. Coding the environmental message

The way that the environment message is coded differs from one problem to another depending on the environment parameters involved and the type and number of sensors used to detect them, for those reasons coding the environmental message can be done as follows :
A mapping procedure should be created to map the sensors output to the coding scheme used in the system and on the type of sensors used which can be a light sensors, a hear sensor, etc. Then the message can enter the system in an acceptable form. In our proposed system we act as if the environment message will arrive to the system in an acceptable form, assuming that it has passed through a mapping procedure because we are performing a simulation.
Our environment contains Cat, Lair and Dog we will use our environmental message of nine bits long each bit represent a sensor information about real world as follows from left to right:
First bit represent presence or absence of Dog sound .
The preceding four bit divided such that first bit represent the distance of Rat from Cat, the distance may be close (1) or far (0). Other four bit represent the relative position of Rat from Cat. The position detected from sensor will be represented a position of Rat from Cat. The position detected from sensor will be represented as in Fig. 1 below:

N-W	N	N-E
W	C	E
S-W	S	S-E

C represent Cat : Other square represented the eight direction.
Four bits from sensor represented eight directions mapping to three bit by using mapping procedure as in table 1 :

N E S W Sensor	Mapping Code	Direction
1 0 0 0	000	north
1 1 0 0	001	north_east
0 1 0 0	010	east
0 1 1 0	011	east_south
0 0 1 0	100	south
0 0 1 1	101	south_west
0 0 0 1	110	West
1 0 0 1	111	north_west

The last four bits is for the distance and relative position for Cat from Lair, and it is in the same manner as for Rat.
There are ten possible action for our system the first bit represent moving or not and other three bit represented the direction. Since our action will consist of four bits as follows :

0000 means still not move .
0001 halted when reached the goal.
1000 means turn to the North and move.
1001 means turn to the North-East and move.
1010 means turn to the East and move.
1011 means turn to the South_ East and move .
1100 means turn to the south and move .
1101 means turn to the south –west and move.
1110 means turn to the west and move.
1111 means turn to the North-West and move.

An initial population have an individual in the form :

No	sound	Dst1	Relative direction from Rat			Dst2	Relative direction from Lair			. .	Move/ Not move	Direction		
1	#	1	#	#	#	#	#	#	#	:	0	0	0	0
0	0	0	D(1-7)			#	#	#	#	:	0	0	0	1
3	1	0	#	#	#	1	#	#	#	:	0	0	0	1
4	1	0	#	#	#	0	D2(1-7)			:	D2(1-7)			

These rules means :
1- When the Cat is closed from Rat then halted.
2- When there is no sound and the Cat is far from Rat then move towards Rat.
3- When there's sound and Cat closed to the Lair then do not move.
4- When there is a sound and the Cat is far from Lair then Cat should move towards Lair.

IV. CONCLUSIONS

Complex behaviors can be obtained from simpler behaviors through a number of composition mechanisms. Also monolithic architecture used is the simplest choice. This kind of architecture can implement any kind of composition behavior in which a LECSYS is capable but the complexity of learning a monolithic controller can be too high.

Strength based fitness is not suitable for non–trivial multi step environment. The only potential advantage of strength value seen is that, it can, in principle, maintain smaller populations.

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