ERA-Polytech2002

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Abstract.
Soccer of robots makes a good example of the problem of the real world that is moderately abstracted. This game has being chosen as one of standard environments for study on multi-agent systems. We are developing the soccer agent basing on the cognitive approach. In this year, we focused on learning problems and rule base for selection of middle and low level behaviours.

Introduction

Currently distributed artificial intelligence and multi-agent systems research directions are considerably paid attention. We see wide using of application multiagent system-technology for design distributed real-time control systems of robots grouped for work with joint goal. The complexity of the design distributed real-time systems has caused the machine learning using. Thus computation complexity is being replaced with system learning.

Soccer is team game in which players have a cooperation and counteraction. This is a real-time game where situation changes dynamically. Soccer was chosen as one of problems for studying on multi-agent systems. We designed the soccer agent using the cognitive approach. We used the rule based decision making method for selection of cooperative actions of the soccer players. We developed the special learning modules for implementation of decision making at high and middle behaviour levels of soccer agent.

The soccer team Polytech100 for participation in RoboCup simulation league was organized in Saint-Petersburg State Technical University in 1999. Currently we have a new team ERA-Polytech2002.

Special team features

Our research is focused on following agent features:
1. The soccer agent is designed as a cognitive system that is the learning intelligence system with nervous-system behaviour, function, and structure (cognitive soccer

agent). The knowledge acquisition is produced with learning using coach in offline mode. The knowledge is accumulating and using in the associative neurological form.

2. The cognitive agents decide the tasks of coordination and choice of behaviours with usage of cognitive structures, which are capable to be learned and to make solutions associatively.
3. The cognitive soccer agent has main cognitive structures based on rule set used for high and middle level behaviour choice in game situation.
4. On middle and low behaviour levels the additional cognitive structures are used to evaluate efficiency of selected behaviour. These evaluations allow to choose appropriated action in behaviour realization.

We widely use this research in teaching students on course AI and intelligent control systems. Soccer Server platform is very useful for our purposes, because it is interesting and easy understanding by students.

We develop special learned modules based on neural and neural logic networks. In our opinion, these modules can advance team behaviour.

World Model

World model is separated in two parts: field representation and field objects modelling if can't get information about it. Its structure is based on CMUnited-99 agent's world model. Each player (teammate or opponent) is kept in agent memory as point on field with confidence parameter. When visual information is absent, object state prediction is carried out by modelling. Also communications between agents is used to get more information of the world's current state. At present, implementation of the world model is simple, based on data set, but we will advance it by addition knowledge base of object interaction and possible coordination in current situation.

Coach

Currently online coach is used only to replace players with lowest stamina. In our opinion, online coach can help also for solution of strategical and tactical tasks. In the future we want to make coach that can change strategy and tactics of team using some statistical information, such as percent of successful passes, main directions of opponent attacks, and other.

An offline coach is used to learn neurological modules that provide middle and low level behaviour (pass, shoot etc.)

Communication

Our agent currently uses communication for two purposes: to share agent's world information with teammates (this will be reduced because of new RoboCup rules), and to realize some common behaviour, such as pass or corner-kick as low-level behaviour or opponent goal attack as high-level behaviour.

In new RoboCup communication rules (i.e. lower communication bandwidth) world state sharing will be reduced, and communication will be attended to make common decisions on game situation.

Skills

The low-level skill functions (dribbling, intercepting, passing etc.) based mostly on CMUnited-99 skills, but we tried to improve some of them by using learned cognitive structures.

The goalie agent has some specific features. It could predict ball motion direction and intercept it.

Strategy

The soccer agent has multilevel behaviour. There are strategical, tactical, and skills levels. The skills level consists of low-level skill functions. The tactical level is middle-level functions (pass, marking an opponent, set-plays etc.). The strategical level selects current behaviour based on global information (about all players, markers and ball) and strategic parameters based on chosen strategy.

Each agent has a set of team strategies (such as attack on right side of field or defence in our penalty area) and scenarios (such as corner-kick scenario or set of passes to send the ball towards opponent goal). Current agent behaviour depends on current strategy, chosen scenario and agent's role.

We used cognitive structures to select behaviour in skills and tactical behaviour levels. In skills level we used learning of pass and shoot direction selection. Tactical level uses cognitive structures to evaluate efficiency of selected actions.

Strategical level uses rule based cognitive structure to select game strategy. The strategy selection depends on analysis of current game situation, opponent team main actions and results of our past actions.

In the cognitive modules we used a fuzzy neurological module developed by our postgraduate student that can be quickly learned and has good ability to generalize different learning examples.

To have possibility to tune the strategy selection manually some of strategy parameters are included in team configuration file.

Team Development

The soccer team Polytech100 for participation in simulation league of RoboCup was organized in Saint-Petersburg State Technical University in 1999. Currently we have a new team ERA-Polytech2002. The team uses a new version of the cognitive soccer agent with special rule base for action selection in current situation and special fuzzy neurological modules for behaviour learning. We used some low level modules of CMUnited-99 library and offline coach for behaviour learning.

- **Team leader:** Dr. Lev Stankevitch
- **Team members:**
  Lev Stankevitch
  - Saint-Petersburg State Technical University
  - Russia
  - Associated professor
  - did attend the competition
  Alexei Kritchoun
  - Joint Stock Company "New Era"
  - Russia
  - programmer
  - did not attend the competition
  Sergei Serebryakov
  - Saint-Petersburg State Technical University
  - Russia
  - graduate student
  - did not attend the competition
  Anton Ivanov
  - Saint-Petersburg State Technical University
  - Russia
  - graduate student
  - did not attend the competition