Simulation League – League Summary

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1 Simulation League

In the simulation league the RoboCup soccer server provides a standard platform for simulated soccer teams to play against each other over a local network. Each team connects 11 player programs and possibly a coach client to the server, which simulates the 2D soccer field and distributes the sensory information to the clients. Besides the team clients the RoboCup soccer monitor or other visualization and debug tools can be connected as a client to the server to provide 2D or 3D visual information or information like game statistics and analysis for the spectators.

Fig. 1. Soccer Simulation Participants

1.1 Introduction

The simulation league forms a counterpart to the hardware leagues which have to create or program robots that actually operate in the real world. In the hardware leagues it is necessary to provide a minimal basis that allows the robots to function in the real world, like, e.g. image processing, the identification of objects, motor control, orientation and localization, before any aspect of strategy or multiagent cooperation can be addressed.

In the simulated world, however, it is possible to detach oneself as far as one desires from the complexities that arise when embedding an autonomous agent in an environment. The environment can be made (at least in principle) fully reproducible and, if required, fully observable and controllable. In addition, in simulation it is possible to quickly and automatically reenact a much larger number of experiments than would be possible with real-world robots. One has accurate control over which models are used for the sensory perception,

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how exactly the synchronization of visual perception and actuators looks like, how precisely agent actuations are translated into the physical reality of the simulation.

The perception/actuation models used in the simulation league are much simpler than the mappings one finds in real-world scenarios; also, presently, the simulation model does not attempt to mimic realistic sensors and actuators though it does include noise and distortion models. However, this simplicity, on the other hand, opens up qualitatively new dimensions. It allows to concentrate to new levels of the pertinent problem, namely learning, teamwork, coordination and cooperation which, at the present time, are still very difficult to address in the hardware leagues. It is this element where the relevance of the simulation league derives from and by which it complements the other leagues of RoboCup. Sensomotoric coordination has still to be incorporated into the model, but forms only a side-issue which has to be integrated into the larger perspective of single- and multiagent learning, coordination and cooperation.

In all these respects, the simulation league goes beyond the implementation of artificial, shallow theoretically defined toy tasks and offers a deep and multi-faceted scenario serving as a challenge to develop AI methods.

1.2 Teams and Tournament

Overview. In the 2002 simulation tournament 42 teams participated, with the traditionally strongly represented countries Japan, Germany and Iran each having seven or more teams in the tournament. Other teams came from China, Australia, USA, the Netherlands, Russia, Poland, Belgium and – for the first time – India. The tournament was organized into a two-round, round-robin stage followed by a double elimination round for the eight strongest teams (quarter-final level). In the first round, the groups had 5-6 members, the first two being seeded according to their performance in RoboCup 2001 and other official tournaments since then. The best three of each group proceeded into the second round, where each group had 6 members. Only the best two teams from each group in the second round proceeded into the double elimination. This configuration enabled most teams to have a large number of encounters and was to make sure that no strong team would be eliminated early on. The success of this concept was indeed corroborated by the strong performance of the eight teams surviving to the elimination round.

The overall playing strength of the teams in the tournament was quite impressive. The playing level of the tournament showed increased and consistent improvement as compared to last year's tournament. More professional and scholarly approaches are being used by a wider number of teams. Modern techniques of AI and machine learning (e.g. particle swarm localization and explicit experimental statistics for certain standard configurations [4] – team Trilearn from the University of Amsterdam (Netherlands) – or Reinforcement Learning – like that used by the Brainstormers) have become a standard approach whose use is not anymore restricted to specialized teams, but has entered the domain of general know-how.

Table 1. Countries represented in the simulation league (soccer tournament)

Country	No. Teams
Japan	11
Iran	9
Germany	8
Australia	3
China	3
Belgium	1
Canada	1
India	1
Netherlands	1
Poland	1
Portugal	1
Russia	1
USA	1

The format of the games has remained the same, with some modifications in details. The evaluation has been replaced by an evaluation challenge; its goal is to probe new features that have been introduced into the simulation environment and to test their influence on the performance of the teams. The idea was to move away from the purely evaluative element which, it was felt, could be achieved with much higher significance and better statistical quality under laboratory conditions. Instead, the goal was to move towards an explorative instrument which would allow to estimate the influence of simulator changes a year before they are bindingly introduced as official tournament features. One of the motivations for this change of policy was this year's milestone discussion (see Sec. 1.3) and the desire to move to a strategy for future simulator development which would be both more long-term and more committed.

Agent Strategies. The tournament was won by the champion of 2001, Tsinghuaeolus, from Tsinghua University in Beijing (China), who, even more clearly than last year, dominated the tournament. Tsinghuaeolus possessed skills, especially ball handling, of a very high quality. Precise passing and quick and effective positioning were the immediately visible capabilities of the team [3].

Motivated by the case-based approach of AT Humboldt [10], the Q formalism is used to create a table that makes a 1-step prediction of which kick achieves which ball displacement. Since this is independent of position, it is sufficient to consider a pure $Q(a)$ table (where a is the action selected and $Q(a)$ its value) instead of a much larger $Q(s, a)$ space usually used. These single-step optimizations are then used to search an optimal kick strategy in the the feasible action space. This allows an intelligent selection of acceptable kick actions, e.g. taking into account to prevent interception of the ball by an opponent or other aspects. It combines the advantages of the Dynamic Programming view of action selection with the possibility to filter actions that do not fulfill minimum requirements.

Table 2. Matches and results of the 8 finalists

Final match	
Tsinghuaeolus	7:0
Everest	

Double Elimination – Winners Round					
FC Portugal	1:0	FC Portugal	0:7	Tsinghuaeolus	1:0
Wright Eagle					
Tsinghuaeolus	2:0	Tsinghuaeolus			
TIT HELIOS					
Brainstormers	3:0	Brainstormers	1:2	Everest	
rUNSWift II					
Everest	3:2	Everest			
UvA Trilearn					

Double Elimination – Losers Round							
Wright Eagle	2:0	Wright Eagle	1:2	Brainstormers	2:1	Brainstormers	0:4
rUNSWift II		Brainstormers					
TIT HELIOS	0:4	UvA Trilearn	1:0	UvA Trilearn		Everest	
UvA Trilearn		FC Portugal					

Tsinghuaeolus' dribbling mechanism is hand-coded and puts high priority on making sure that the ball is kept kickable at all times and that the ball is kept out of all opponents kickable areas. Moving forward to the desired direction carries only a second priority in this model.

Another aspect which is tackled by Tsinghuaeolus is the creation of a globally coherent strategy from individual local observations [11]. The decentralization of the typical RoboCup scenario and the very limited bandwidth creates a pressure on the agent teams to make decisions individually for each agent while, in the same time trying to improve the situation for the whole team. For this purpose, Tsinghuaeolus uses a task decomposition mechanism. It decomposes the global task into subtasks that can each be executed by a single agent. The individual tasks are then allocated to that agent that is able to carry them out, creating so-called *pairs of arrangements*. These arrangements are evaluated to attain a measure for the performance of the complete task. A branch-and-bound search is performed on the set of arrangements to find the set of arrangements achieving the highest score (see also [3]).

A *mutex* mechanism is applied that allows to treat actions which are mutually exclusive as compared to actions which can be combined. In addition a mixture term for the joint influence of actions is included in the calculation. A specific element of the Tsinghuaeolus design is the mediator which is an architectural unit responsible for resolving wasteful or mutually exclusive action selection. In ambiguous cases, the system relies on the natural dynamics of the robot soccer environment to break the symmetry and to resolve the decisions. It turns out that the mechanism, together with the selected utility functions, is sufficiently robust to work also when the agents differ in what they perceive (as is the case for the RoboCup scenario).

Second in the tournament was the team *Everest* [9] from the Beijing Institute of Technology. Their code was based on Tsinghuaeolus 2001 and their playing style was similar, though they were clearly inferior to the champion while superior to a large number of strong teams. Team Brainstormers from the Universities Karlsruhe and Dortmund (Germany) achieved the 3rd place and thereby maintaining their consistent top-class performance displayed over the tournaments of the last years. An increasing number of the Brainstormers capabilities have been trained via Reinforcement Learning in the last years, this year adding a learned behavior for selecting the best pass receiver to the repertoire [8]. Another element learned by Brainstormers using Reinforcement Learning techniques are attack situations which, up to now, used to have been hand-coded by the Brainstormers team. Thus, the Brainstormers model acts as paradigm that proves that it is indeed possible to actually learn significant aspects of a soccer player strategy [7].

The fourth place in the tournament was achieved by UvA Amsterdam. This team applied several principled approaches to develop useful strategies. It used particle filters for self- and ball localization as a specific instantiation of a Bayesian filtering approach [4] which improves over earlier approaches to Bayesian filtering [2].

Another aspect which has been tackled in a principled way by UvA Amsterdam is the scoring. They devise experiments in which scoring attempts are undertaken under controlled conditions. This yields a probability distribution for the success of goal shots. Then, a probability is derived that a ball is successfully intercepted by the goalkeeper and feature detection mechanisms as well as discriminant analysis is used to separate the successful from the unsuccessful cases. This results in a powerful and principled way of analyzing whether a goal kick is going to be successful or not. It allows the UvA players to indeed realize a goal-kicking situation with a high probability when the opportunity arises. Such an approach is closely related to minimax distributed dynamic programming approaches which become increasingly popular.

These minimax approaches are relatively fragile with respect to the selection and stability of their strategies. To overcome this problem and to extend the strategy horizon of their agents, Baltic Lübeck provides its players with explicit micro-strategies [1]. These are applied in situations where the player do not need to react immediately, but have a certain degree of freedom to prepare longer-termed moves. These micro-strategies can be seen as puzzle pieces that may be used to describe possible movements of players. These pieces are then adapted into the players' current situation context whenever they fulfill certain properties. They can prepare a flank or provide movement patterns to escape marking. Also, they serve to encourage or exclude certain pass patterns.

The problem of specifying the behavior of multiagent teams was tackled in an approach by RoboLog Koblenz. The team behavior is specified with UML statecharts and can be translated into running Prolog code for each agent [5]. An agent processes one transition of the statechart in a simulation step for atomic actions, it can execute parallel transitions for actions that can be performed simultaneously.

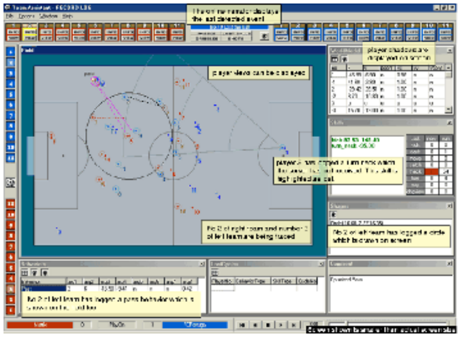

Fig. 2. SBCe "Team Assistant"

Presentation Tools. This year's presentation tournament was won by the SBCe "Team Assistant" [6] from Shahid Beheshti University (Iran) which was, rather than the favorites in earlier tournaments not a visualization tool that would create an appealing visual presentation of the simulation games, but a debugging software to allow team developers to accurately control and analyze the player behaviors in specific game situations.

Fig. 3. Wright Eagle "Magic Box"

1.3 Milestone Discussion

An important issue of this year's event was the high-profile discussion of the further development of the simulation league. In the past years the development of the simulator has seen important innovations, amongst other things a neck, heterogeneous players and a complex coaching language. However, these developments have been taking place in principle on a year-to-year basis. It has then been increasingly felt that the simulation league should adopt an explicit long-term perspective that will, at some point, integrate with the other leagues to the ultimate goal of RoboCup 2050. At the same time, one would desire to develop the simulator in such a way as to allow teams to expand upon their techniques and capabilities while not disrupting achieved capabilities without good reason.

Therefore, a milestone map was conceived and discussed in a panel presentation during the RoboCup Symposium. One of the most important questions concerning the future of the simulation league is whether it should remain on a relatively high level where one focuses on the multiagent aspect or whether it should become increasingly concrete and close to real robot simulations. To tackle this problem, it was suggested to support the high-level simulation for the next decades while at some point initiating the development of realistic simulators. After a certain phase of overlap, the focus would then shift to the more realistic simulations and the high level view would begin to phase out.

A central aspect to simulator development has been the pressure to extend the present 2D scenario to 3D which introduces a new level of complexity. While this idea has been discussed in the past years without materializing into action, in this year the simulation league has committed to elevate this aspect to the rank of a central milestone. It is hoped that preliminary 3D competitions can be held already during RoboCup 2003 in parallel to the 'classical' 2D competition. Further milestones suggested were the introduction of nonlinear and historic noise types, an abstract leg dynamics (which would create a link between the high level and the realistic simulation) and concepts to allow large scale statistical evaluations. In addition, the milestones included the introduction of realistic dynamics, collision models together with event-based simulation that would no longer be implemented as a pseudo-synchronous perception/actuation cycle, but would capture the spirit of realistic situations with no true synchronization. Long-term milestones for the "realistic simulator" branch included the development of humanoid simulators.

All these changes require a systematic reorganization and a strongly improved modularization of the present simulator. Following the milestone discussions at RoboCup 2002, the simulation maintenance team has committed itself vigorously to address this situation. At the present time, it is actively and decisively pursuing the required refactoring of the simulator and the implementation of the central 3D milestone. A version is expected to be available in RoboCup 2003 and to form part of next year's evaluation challenge as the first official platform at which innovations to the simulation model are being presented to the public.

1.4 After the Competitions

To further have the possibility of testing teams and in order to provide a competition-like setting all year long the Simulated Soccer Internet League has been established after RoboCup 2002 was over. Developers install their teams on the competition machines, hosted at the University of Koblenz, via the Internet. The server and teams are started automatically, but other than during the RoboCup competitions a slowed down server is used to keep the number of required machines low. Each time an Internet league round is over, developers can download the recorded log files and use them for analysis of their team's behavior.

Last but not least a further novelty is the availability of the RoboCup competition matches in Flash file format, so that RoboCup 2002 Simulation League matches can be replayed with simply a web browser using a flash plug-in. The game files are available from the results section on
`http://www.uni-koblenz.de/~fruit/orga/rc02/`

2 Results and Teams

Table 3. Top 8 teams, team competition

1	TsinghuAeolus	China
2	Everest	China
3	Brainstormers	Germany
4	UvA Trilearn	Netherlands
5	Wright Eagle	China
5	FC Portugal 2002	Portugal
7	TIT HELIOS	Japan
7	rUNSWift	Australia

Table 4. Winners, coach competition

1	FC Portugal	Portugal
2	Helli-Respina 2002	Iran

Table 5. Winner, presentation competition

1	SBCe	Iran

Table 6. Qualified presentation teams (6 teams from 5 countries)

Wright Eagle	Univ. of Sci. & Tech. of China	China
RoboLog Koblenz 2002	Universität Koblenz-Landau	Germany
SBC++	Shahid Beheshti University	Iran
SBCE	Shahid Beheshti University	Iran
YowAI2002	The University of Electro-Communications	Japan
FC Portugal 2002	University of Porto and University of Aveiro	Portugal

Table 7. Qualified teams for coach competition (9 teams from 5 countries)

Wright Eagle	Univ. of Sci. & Tech. of China	China
RoboLog Koblenz 2002	Universität Koblenz-Landau	Germany
Mainz Rolling Brains	University of Mainz	Germany
The Dirty Dozen	University of Osnabrück	Germany
Helli-Respina 2002	Allameh Helli High School	Iran
Pasargad	AmirKabir University of Technology	Iran
Sharif Arvand	Sharif University of Technology	Iran
FC Portugal 2002	University of Aveiro and University of Porto	Portugal
ATTUnited-2002	AT&T Labs - Research	USA

Table 8. Team Competition (45 teams from 14 countries)

Cyberoos2002	CSIRO	Australia
rUNSWift	University of New South Wales	Australia
CrocaRoos 2002	University of Queensland	Australia
Cow'n'Action	ULB	Belgium
UBCDynamo02	University of British Columbia	Canada
Everest	Beijing Institute of Technology	China
SHU2002	Shanghai University	China
Tsinghuaeolus	State Key Lab of Intelligent Technology and Systems	China
Wright Eagle	Univ. of Sci. & Tech. of China	China
AT Humboldt 2002	Humboldt University Berlin	Germany
RoboLog Koblenz 2002	Universität Koblenz-Landau	Germany
BUGS	University of Bremen	Germany
Virtual Werder 2002/A	University of Bremen	Germany
Brainstormers	University of Karlsruhe	Germany
Baltic Luebeck	University of Lübeck	Germany
Mainz Rolling Brains	University of Mainz	Germany
The Dirty Dozen	University of Osnabrück	Germany
IITKanpur	Indian Institute of Technology Kanpur	India
Helli-Respina 2002	Allameh Helli High School	Iran
PolyteCS	AmirKabir University of Technology	Iran
Iranians	Iran University of Science And Technology	Iran
Persepolis	JavanFarhangsara	Iran
AVAN	Qazvin Islamic Azad University	Iran
Sharif Arvand	Sharif University of Technology	Iran
Thunder	Tehran University	Iran
Matrix	University of Shahid Beheshti	Iran
UTUtd	University ofTehran	Iran
chagamma	AIST/JAIST	Japan
Puppets	Fukui University	Japan
RaiC02	Fukui University	Japan
Harmony	Hokkaido University	Japan
Toricolor Diamonds	Kanazawa Institute of Technology	Japan
YAMAKASA	Kyushu University	Japan
Gemini	National Institute of Advanced Industrial Science and Technology	Japan
Hana	Osaka Prefecture University	Japan
YowAI2002	The University of Electro-Communications	Japan
TIT HELIOS	Tokyo Institute of Technology	Japan
TUT-ChoNaSo	Toyohashi University of Technology	Japan
UvA Trilearn	University of Amsterdam	Netherlands
WROCLAW2002	Wroclaw University ofTechnology	Poland
FC Portugal 2002	University of Aveiro and University of Porto	Portugal
ERA-Polytech	New ERA Company & St.Petersburg Technical University	Russia
n-th.com	Company n-th.com	Ukraine
ATTUnited-2002	AT&T Labs - Research	USA
Wahoo Wunderkind	University of Virginia	USA

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