FC Portugal Team Description: RoboCup 2000 Simulation League Champion

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Abstract. FC Portugal is the result of a cooperation project between the Universities of Aveiro and Porto in Portugal. The project started in February 2000 and only three months later, in Amsterdam, FC Portugal became the first European Champion of RoboCup scoring a total of 86 goals without conceding a single goal. Three months later, in Melbourne, FC Portugal became RoboCup Simulation League World Champion scoring 94 goals, again without conceding any goal. This paper briefly describes some of the most relevant research developments and innovations that lead to FC Portugal team success.

1 Introduction

Soccer is a very complex game, both very animated to play and exciting to watch. The soccer server simulator [2], although being a 2D simplified soccer simulation, manages to keep most of this complexity, animation and excitement. Because of this, we argue that, in the simulation league on RoboCup, to be successful and win, a team must be able to play like a real soccer team. Thus, FC Portugal project was conceived as an effort to create intelligent players, capable of thinking like real soccer players and behave like a real soccer team. Expertise from real soccer experts (players, fans and coaches) was gathered and adapted to the specificities of this 2D simulation before creating a team strategy and agent architecture capable of supporting real soccer reasoning.

CMUnited99 publicly available low-level source code [7] was used as a starting point for FC Portugal. This saved a huge amount of time in the beginning of the project and enabled our initial research to be mainly focused on multi-agent cooperation and communication issues while concentrating on some low-level details later on. FC Portugal introduces several research innovations in RoboCup:

- Flexible team strategy composed by tactics, formations (used inside tactics) and player types to be used in different game situations;
- Extensive use of the concept of player type defined at three different behaviors levels (strategic, ball possession and ball recovery);
- Distinction between strategic and active situations;
- Situation based strategic positioning mechanism;
- Dynamic positioning and role (player type) exchange mechanism based on utility functions;
- Intelligent communication based on teammate modeling and on a communicated world state;
- Intelligent perception through a strategic looking mechanism based on utility functions;
- Integration of soccer knowledge in the positioning, ball possession and ball recovery modules;
- Very strong kick based on online optimization;
- An intelligent goal keeping strategy for 2D soccer;

P. Stone, T. Balch, and G. Kraetzschmar (Eds.): RoboCup 2000, LNAI 2019, pp. 29-40, 2001.

- Marking techniques based on teammate modeling;
- An agent architecture, multi-level world state and high level decision module capable of supporting this approach;
- Visual debugging to show what the agents see, hear, feel, think and do;
- Offline client to repeat and fully debug the execution of an agent;
- World state error analyzer.

Unfortunately due to space limitations it is impossible to fully explain all these issues in this paper and so, some of them are only explained at an overview level. Throughout this article we assume the reader has good knowledge about the RoboCup initiative [3] and soccer server [2] and basic knowledge of artificial intelligence and real soccer.

The structure of the article is as follows. Section 2 describes FC Portugal team strategy, the concepts of tactic, formation and player type, the situation based positioning mechanism and the dynamic positioning and role exchange mechanism. Section 3 is concerned with the agent architecture and the high level decision module, while the next section describes the intelligent perception and communication methods used by FC Portugal. Section 5 describes the integration of soccer knowledge in the agent's individual decision modules and the next section describes some of the low-level skills implemented in our agents. Several development tools implemented in this project are described in section 7 and we conclude the paper with some results and conclusions.

2 Team Strategy

Tactics, formations, positionings and player types are common concepts in soccer and a good RoboCup team must use them in order to be able to play simulated robosoccer. CMUnited brought the concepts of formation and positioning to RoboSoccer [6,9] and used dynamic switching of formations depending on the result and time of the game. We extended this concept and introduce tactics, situations and player types. FC Portugal team strategy definition is based on a set of player types (that define player strategic, ball possession and ball recovery behaviors) and a set of tactics that include several formations (433, 442, Open433, 532, etc.). Formations are used for various game situations (defense, attack, transition from defense to attack, etc), assigning each player a base strategic position and a player type. Figure 1 shows the structure of FC Portugal team strategy.

2.1 SBSP - Situation Based Strategic Positioning

One of the main strengths of FC Portugal is its positioning mechanism based on the clear distinction between strategic and active situations. SBSP mechanism is used for strategic situations (in which the agent believes that it is not going to enter in active behavior soon). For active situations, the agent position on the field is defined by specific ball possession, ball recovery or stopped game decision mechanisms.

To calculate its base strategic position, the agent analyses which is the tactic and formation in use and its positioning (and corresponding player type). This position is then adjusted according to the ball position and velocity, situation (attack, defense, scoring opportunity, etc.) and player type strategic information. Player strategic characteristics include ball attraction, admissible regions in the field, specific positional characteristics for some regions in the field, tendency to stay behind the ball, alignment in the offside line, and attraction by specific points in the field in some situations. Due to lack of space, we present only a simplified SBSP algorithm (that does not consider ball velocity, attraction rectangles and attraction points and simplifies the use of situations applying them only for choosing the formation):

```
/* Variables: P – Player Positioning, BSP – Base Strategic Position,
  PT – Player Type, BallP – Ball Position, SP – Strategic Position */

Vector SBSPPosition(Positioning P) {
  Vector BSP = getPosition(Tactic, Formation, P);
  PType PT = getPlayerType(Tactic, Formation, P);
  SP = adjustSBSPPosition(BSP, PT, BallP);
  return SP;
}

Vector adjustSBSPPosition(Vector BSP, PType PT, Vector BallP) {
  SP = BSP + (BallP.X*BallAtraction.X(PT), BallP.Y*BallAtraction.Y(PT));
  If alignsOnDefenseLine(PT) then SP = adjustToDefenseLine(SP, BallP)
  If behindBall(PT) then SP = adjustToBehindBall(SP, BallP)
  If offsidePosition(SP) then SP = adjustToOnside(SP)
  If not inside admissibleRectangle(PT) then
   SP = adjustToAdmissibleRectangle(SP, admissibleRectangle(PT))
  return SP;
}
```

This positioning system enables the team to move like a real soccer team, keeping the ball well covered while players remain distributed along the field.

2.2 Player Types

Soccer teams are heterogeneous in nature, including players with different abilities, performing different roles. Although simulated agents are homogeneous (using soccer server 6.06), using heterogeneous behaviors gives the team greater flexibility. For example, midfielders must be more aggressive players, while central forwards must be good shooters and central defenders must be positional players. FC Portugal uses extensively the concept of player type. Player types are built by defining a set of different characteristics for players that include: strategic, ball possession and ball recovery characteristics.

Strategic characteristics are the SBSP parameters for each player type. For example, a given player type may like to run a lot in the field, taking part in defensive movements but also running to the opponent's area when the game situation is changed to attack. Other

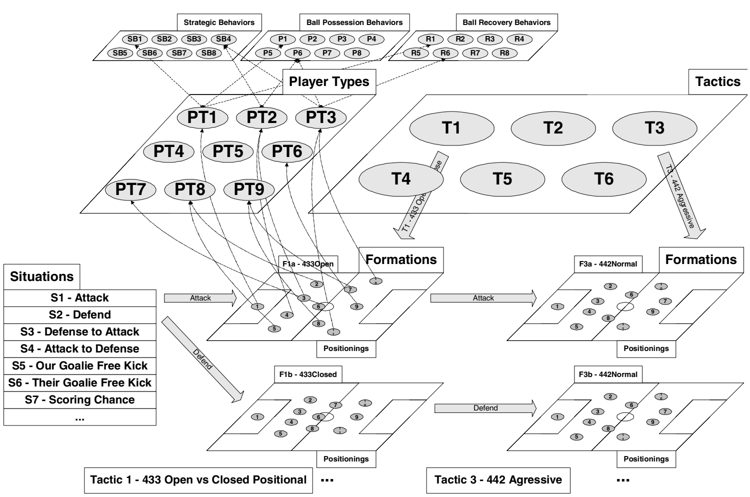

Fig. 1: Team Strategy composed of Tactics, Formations and Player Types

player types may remain strategically more static keeping their energy for active situations. Another example is concerned with the tendency of a player to integrate the defense line (in defensive situations) or to position itself in a possible scoring position (in offensive moves).

Ball possession characteristics concern the player type behavior, in active situations, when it has the ball controlled. These characteristics include the relative tendency for shooting, dribbling, passing, etc. Different weights are used for the evaluation of each of the action types. For example, a safe passer may give a very high weight to the confidence that the receiver is prepared to receive the pass and to the opponent's interception possibilities and low weights for positional gain and shooting possibility values of that pass.

Ball recovery characteristics are used to define the behavior of player types, in active situations, without the ball. They define the tendency of that player type to intercept, mark, mark pass lines, etc. For example, a player with the positional defender player type (used by FC Portugal central defenders) does not mark pass lines or tries risky interceptions. This type of player keeps its strategic position, entering in active ball recovery actions safely.

2.3 DPRE - Dynamic Positioning and Role Exchange

DPRE is based on previous work from Peter Stone et al [6,9] that suggested the use of flexible agent roles with protocols for switching among them. In FC Portugal, players may exchange not only their positionings (place in the formations) but also their player types in the current formation. Positioning exchanges are performed only if the utility of that exchange is positive for the team. Utilities are calculated using the distances from the player's positions to their strategic positions, the importance of each positioning and the adequacy of each player to each positioning in the formation on that situation.

Although spatial coordination is enough to guarantee that positioning exchanges are successful, coordination is reinforced by communication. Triple positioning exchanges and positioning covering (a player covers an unguarded important position in the field) are also possible but were not used on the team in RoboCup 2000. Contrarily to CMUnited that found out that role exchange was not useful on their team and did not use it in RoboCup 99, our experimental results showed that DPRE increases significantly team performance keeping stamina levels higher and the number of uncovered useful positions significantly reduced. FC Portugal with DPRE wins about 85% of the games against the team without DPRE. Also, this mechanism enables the team to play using only 6 or 7 players on the field while winning to every RoboCup 99 available team.

3 Agent Architecture and High Level Decision Module

FC Portugal, team strategy includes the knowledge about tactics, formations, player types, situations, intelligent communication and perception strategies and opponent modeling strategies. These structures are instantiated initially by a human coach according to the opponent team characteristics.

The main control loop of our agents uses perception interpretation and action prediction to update the world state [9] and then use a high-level decision module to decide the next action to do. Information model in FC Portugal is a multi-level structure with data at four levels of abstraction:

- **Global Situation Information** – High-level information like result, time, game statistics (shoots, successful passes, etc.) and opponent behavior, used to decide the team tactic at a given moment;

- **Situation Information** – Information relevant to the selection of the appropriate formation and for the SBSP, SLM and ADVCOM mechanisms;
- **Action Selection Information** – Set of high-level parameters used to identify active situations and to select appropriate ball possession or ball recovery behaviors;
- **World State** – Low-level information, including positions and velocities of players and ball.

The high-level decision module (Fig. 2) decides not only the player action but also the tactic, formation, positioning and player type of the player. This high-level decision module initializes some internal structures and enters the agent main control loop. This loop starts by running the STRATEGY module to decide the current tactic and formation. Then, it analyses DPRE possibilities, performs intelligent communication and decides where to look. If the game is stopped, stopped game positioning is performed. If an active situation is not identified SBSP is performed, otherwise if the agent has the control of the ball, an appropriate ball possession action is selected and if not, an appropriate ball recovery action is selected. The loop closes with modules not directly connected with decision-making: action execution and multi-level world state update.

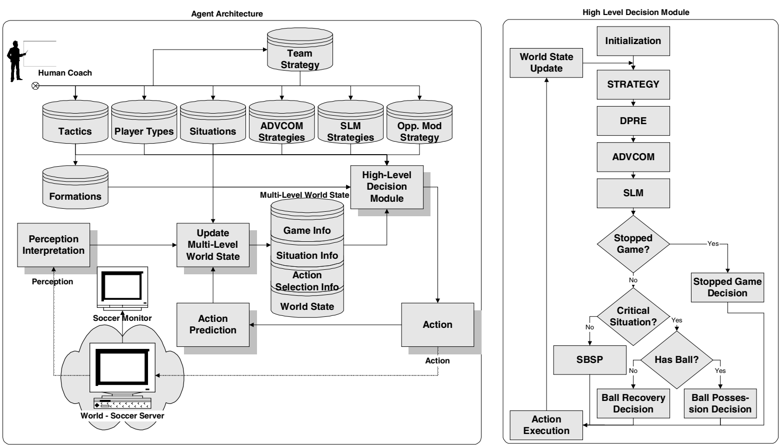

Fig. 2. Agent Architecture and Control Flow of the High Level Decision Module.

4 Intelligent Perception and Communication

FC Portugal low-level world state model is based on the world state model from CMUnited99 source code [7]. This model keeps track of object positions and velocities in field coordinates assigning a confidence value to each of these values. Position confidences in CMUnided99 source code are assigned their greatest value (1.0) when the object is seen and then decay with time (in cycles). FC Portugal position confidences are also linked with the precision a player could get when he saw the object. When a player sees an object, he assigns it a confidence that decays with that object distance to the player. Soccerserver visual info precision degrades with this distance so this is reflected in the position confidences. A similar reasoning is performed for velocity confidences. This kind of confidence assignment is especially useful when players share their world state knowledge through communication.

4.1 ADVCOM - Intelligent Communication Mechanism

Communication in single channel, low bandwidth, and unreliable domains should only be used when it is useful from a team global point of view. The main research challenges are concerned with deciding what and when to communicate. FC Portugal agents use communication in order to:

- Maintain agent's world states updated and precise by sharing individual world states at appropriate moments;
- Increase team coordination by communicating useful events (for example a pass or positioning swap).

When communication is performed, FC Portugal players communicate their complete world state and eventually some higher-level events. The main innovation of our communication strategy is related with the use of teammate modeling techniques and event information (like ball velocity changes), to evaluate the communication utility and decide whether or not to communicate. Agents communicate when they believe that the utility of their communication is higher than those of their teammates. When a given player witnesses a useful event, he reasons if he should communicate that event or if other teammates are in better conditions to do it. If no useful event (e.g. ball drop, ball velocity change, pass, etc.) is detected, players' reasoning is concerned with the amount of useful information that their world state may contain to the teammates. To enable this kind of reasoning, agents maintain a "communicated world state". Communicated world state is updated using only the aural information, without using any other perception or action prediction information. Players use this communicated world state as an indication of their teammates knowledge.

Communication utility is calculated by adding the confidence increments of the world state object positions relatively to the corresponding confidences in the communicated world state. The same type of reasoning is applied to the ball confidence values. After a player communicates, he will not communicate for a while (because his world state is similar to the communicated world state).

4.2 SLM - Strategic Looking Mechanism

In a complex domain such as soccer, sensors must be coordinated and used in an intelligent way to enable an agent to maintain an accurate world state. However, the interest of a given part of the world state is different according to the situation. If an agent has the ball controlled and is near the opponent's goal, then the position and velocity of the opponent's goalie is a very important part of the world state, while the positions of the players near the middle of the field have reduced interest.

FC Portugal SLM intelligent perception mechanism decides the agent looking direction according to the player type, formation, player position and with the confidence it has on the positions and velocities of all the objects in the field. For each of the possible looking directions, a utility measure is calculated that estimates the usefulness for the agent to look on that direction. This utility is based on the world state confidence increment expected by looking on that direction. When evaluating the confidence increment, players use different weights for different objects depending on the situation, ball position and self position. The best looking direction is then selected and an appropriate turn neck command is issued.

5 Integrating Soccer Knowledge

Most of the player's individual decisions are based on soccer knowledge adapted to the 2D simulation. This knowledge includes the way to decide what to do with the ball (pass, shoot, forward, dribble or hold), without the ball in active situations (intercept, mark opponent, mark pass line, approach the ball, cover the goal, get free, etc.) and in stopped game situations. Also, the definition of tactics, formations and players' strategic behavior strongly considers real soccer playing and coaching expertise.

5.1 Ball Possession

If a player has the ball its decision is based on the evaluation of the following options:

- **Shoot:** Shoot to a given spot in the opponent's goal. Hard shoots and fast shoots are considered for different scoring opportunities;
- **Pass:** Pass the ball to a teammate to a given position. Passes are assumed to be fast (although several velocities are considered) and made to a position near the receiver;
- **Forward:** A forward pass sends the ball to a point in front of a given player so that the player may run and get the ball ahead. While normal pass receptions are planned so that the ball is still moving quickly, forward passes are planned so that at the reception point the ball is almost stopped. This ball behavior allows a forward to be done to a point that is far from the receiving player if that player will be the first to get there.
- **Dribble:** Advance in the field, to a given position, keeping the ball always controlled;
- **Hold:** Keep the ball controlled, avoiding opponents without moving.

The best shoot, pass, forward, dribble and hold are compared to compute the final decision. To evaluate each of the possible options, several evaluation measures, with different weights, are used. For example, to evaluate a pass, 12 different evaluation measures, are used (including the positional gain, destination spot congestion, possibility of opponent interception, etc.). These measures are calculated using the action selection information in a qualitative scale {VGood, ..., VPoor} and are combined using different weights. A maximum of 72 pass options (at 5 degree interval) are evaluated. In most circumstances, backward passes are not considered.

5.2 Ball Recovery

Players should select this behavior when they detect that ball recovery is possible, or when they find themselves in a critical defending situation where, although ball recovery is not probable immediately, they find it advantageous for the team (for example marking a pass line or covering the goal). The ball recovery behaviors implemented in FC Portugal are:

- **Ball Interception** – Run to the fastest possible ball interception point;
- **Ball Passive Interception** – Intercept the ball, not in the fastest point but in a more advantageous point, although taking more time;
- **Mark Pass Line** – Mark a pass line from the opponent that is (or will be) in control of the ball, to another opponent. Marking is performed if a player detects a useful and uncovered passing line that may be well marked (better than any other teammate) near that player strategic position;
- **Approach Ball Position** – Player approaches ball position in order to reduce opponent options;
- **Mark Opponent –** Mark the player that has the ball keeping him from advancing in the field;
- **Cover Goal -** Player tries to get a good defensive position by keeping his position between ball position and its own goal.

The process of selecting between these actions is performed based on several characteristics of the current situation and of the high level world state using an extensive set of rules. The goalie defensive strategy is based on five actions: mark position, passive interception, active interception, goal interception and catch. FC Portugal Goalie strategic position is usually quite near the limits of the penalty area

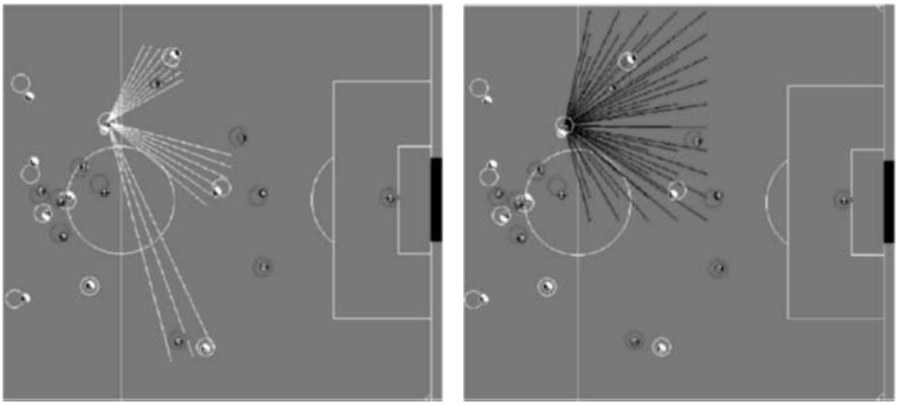

Fig 3: An example of Passes and Forwards considered for evaluation.

6 Low-Level Skills – Optimization Kick

Since FC Portugal research is not focused on low-level skills and there is very good source code for low-level skills available on the Internet, most of our skills are adapted from CMUnited99 source code [7]. However, and since this is a crucial skill, we implemented a new strong kick based on optimization techniques.

The probability of success of players' actions depends heavily on the ball handling ability of players. Players should be able to kick the ball with the fastest possible speed. Soccerserver, allows the possibility of a player to kick the ball in successive cycles. If this possibility is efficiently exploited, players can provide the ball with a greater speed than a single kick would permit. However, the problem of finding these accelerative kicking sequences is not trivial. Several approaches have been proposed either analytically [7] or by using learning techniques [1,5]. We modeled the problem as an optimization problem and applied some simple (but effective) search algorithms in order to find these kick sequences. Optimization is executed online, during the game, for each particular situation each time the player decides to kick the ball powerfully.

Online search is divided in two stages. The first stage uses a random search of kick sequences to select the "best" kick sequence while the second stage tries to improve the kick sequence found in the previous stage.

Our random search uses the following algorithm. Random kicks are performed until the ball gets out of the kickable area. When this happens, the last kick is replaced by an analytically determined kick to adjust the final angle. Each kick sequence is analyzed by an evaluation function that considers the final speed of the ball, the kick sequence length and the number of cycles in which opponents may also kick the ball. The kick sequence with the best value is selected. Simple heuristics are applied in order to conduct the search to good solutions.

After random search, the best kick sequence is improved using a hill-climbing algorithm. This sequence is disturbed by random noise and if the resulting kick sequence is better it is considered as the new best kick sequence. When it improves the result, the last disturbing noise is reused in our hill climbing because that direction in the search space should be tested again. Hill climbing improved results taking an insignificant time (below 0.5 ms for Pentium 200MHz). Without using the limits of the kickable area (to account actuators and sensors noise) this approach allowed us a final speed median of 2.47 taking 3 or 4 cycles (over 2000 tests) for a typical case of ball stopped in front of a player.

Online search of the best kick sequence based on optimization techniques is a novel approach to the problem of kicking the ball powerfully in simulated RoboSoccer. This approach enabled FC Portugal players to kick the ball in any direction (without turning) taking few simulation cycles and quite powerfully.

7 Development Tools

7.1 Visual Debugger

CMUnited99 introduced the concept of layered disclosure [8] and extended the functionality of the logplayer application (distributed with the soccerserver) to support it. Their extended logplayer included the possibility of synchronous visualization of the game (using soccermonitor) and of one of the players reasoning (at several levels of abstraction) saved in action logfiles. We have integrated the two applications (logplayer with layered disclosure and soccermonitor) in a powerful team debugging tool which includes several new features.

Visual information is much more easily handled than text information. Soccermonitor [2] includes the possibility of drawing points, lines and circles over the field, but this functionality is not reported as being used by other teams. The possibility of drawing over the field provided by soccermonitor was exploited, modified and extended (possibility of drawing text over the field). On the other hand, we extended the log action files syntax so

Fig. 4 : Integrated debug application window

that they could include draw commands. As with action log messages, draw commands can be inserted at different reasoning levels of abstraction. Normal action debug messages still exist but they are shown in scrollable debug text windows.

The debugger determines the real world state based on the visualization information saved in server record log files. The real positions and velocities of all objects are calculated and probable last player commands are deduced from a set of simple rules that reason on world state changes. This internal view of the real world state is shown in a text window. Some features (ball position/velocity, selected player position/velocity and ball distance) are shown directly over the field.

We used the possibility of drawing text over the field quite extensively to show player action mode, synchronization, basic action, lost cycles, evaluation metrics, position confidences and to compare players beliefs on its (and ball) position/velocities with real values. Drawing circles and lines over the field was used to show player beliefs on object positions, player view area, best pass, shoot or forward, communication events, etc (Fig 4).

We have used this tool to tune strategic positions, test new behaviors, tune the importance and precision of each of the evaluation metrics used in the high-level decision module, test world update, communication and looking strategies empirically, analyze previous games of other teams, etc.

7.2 Offline Client

In some situations the action log files created by our players were not enough to understand what was really happening in a certain situation. A much finer debugging degree can be achieved by employing our offline client tool. The principle of the offline client is that we can repeat the execution of a player over exactly the same setting of a previous game without the intervention of the server and without real-time constraints. Then we can use a normal debugger (like gdb) to examine the contents of all variables, set breakpoints, etc at the execution situations we want to analyze. A special log file, that records every interaction with the server and the occurrence of timer signals, must be generated to use the offline client. If an agent has probabilistic behavior some more information might be needed (the only probabilistic behavior of our agents is the optimum kick). The offline execution of an agent is achieved through a stub routine that reads previously saved server messages from the log file instead of reading network messages. Player's behavior is maintained, as it is not affected by the substitution of this stub routine. The execution of a normal debugger over this offline client allows a very fine tracking of what happened.

8 Results and Conclusions

Although being a very recent team, FC Portugal won the European RoboCup 2000, held in Amsterdam (May 29- June 2), and the World RoboCup 2000, held in Melbourne (August 28 - September 3). In these two competitions, FC Portugal scored a total of 180 goals, without conceding a single goal. Table 1, summarizes FC Portugal's results in both competitions.

In Amsterdam FC Portugal used almost unchanged CMU basic skills. However, the team beat easily other teams with much better low-level skills (e.g. Essex Wizards [4] with an excellent dribbling, Brainstromers [5] with an amazingly powerful kick). The reasons for this (apparently strange) success were:

- **Team strategy**, based on very flexible tactics with well conceived formations for different game situations and flexible player types;

- **Situation based strategic positioning** that (enhanced with DPRE) enabled the team to move in the field as a real soccer team;
- **Individual decision modules** (ball possession and ball recovery) that enabled the agents to think like real soccer players. Knowing in advance that their low level skills were inferior they were able to play with that limitation;

FC Portugal could not score many goals, event against some medium quality teams. This was due to the poor low level skills and imprecise world state of the agents that prevented the team to play a faster type of game. With this limitation, FC Portugal used the SBSP mechanism combined with the individual decision modules to explore the free space on the field to attack and to cover that same free space while defending. The goals were almost always scored going through the (usually uncovered) side wings of the opponents and crossing to a point near the opponent's goalie where a FC Portugal player could easily score with a light kick. Against teams that had good positional systems or that defended with a huge amount of players inside their penalty box, this playing type revealed to be less effective.

Table 1: Scores of FC Portugal in EuRoboCup2000 and RoboCup2000.

Euro RoboCup – Amsterdam	Score
Essex Wizards (England)	3 – 0
Lucky Luebeck (Germany)	13 – 0
Cyberoos (Australia)	4 – 0
Pizza Tower (Italy)	22 – 0
Polytech (Russia)	19 – 0
PSI (Russia)	6 – 0
Wroclaw (Poland)	13 – 0
Essex Wizards (England)	5 – 0
Karlsruhe Brain. (Germany)	2 – 0
Total Score	86 – 0

RoboCup 2000 - Melbourne	Score
Oulu2000 (Finland)	33 - 0
Zeng2000 (Japan)	18 - 0
Robolog (Germany)	20 - 0
Essex Wizards (England)	7 - 0
Karlsruhe Brain. (Germany)	3 - 0
YowAI (Japan)	6 - 0
ATTCMUnited2000 (U.S.A)	6 - 0
Karlsruhe Brain. (Germany)	1 – 0
Total Score	94 - 0

In Melbourne, several teams used positioning mechanisms similar to SBSP, (mostly the ones that competed in Amsterdam). So, the positional advantage, FC Portugal had in Amsterdam, was only visible in games against weaker teams. In the games against very good teams, FC Portugal superiority was related, not only with the team strategy, SBSP, DPRE and decision modules, but also with:

- **Intelligent perception and communication**, that enabled the players to maintain a very precise world state but at the same time keeping alert to useful events (like ball velocity changes);
- **Optimization kick**, that enabled the players to kick the ball in a very fast and powerful way;
- **Marking techniques**, responsible for not letting the other teams play their normal game because almost all useful pass lines were always marked by a FC Portugal player;
- **Debugging tools**, which enabled to tune all FC Portugal configurable strategies and parameters in a very easy and robust way.

The development of a strong kick and the availability of a much better world state, enabled FC Portugal to change its type of playing. Instead of the medium velocity passes, progression by the wings and crosses to players near the opponent's goal, it was now possible to do very fast passes in the middle of the field and to shoot with success from outside the penalty box. FC Portugal playing game became much more flexible. With teams with lots of players in the center of the field, the team plays identically to the Amsterdam team. But against other types of teams, FC Portugal adjust its playing mode. Several teams used very defensive strategies with lots of players inside the penalty box, against FC

Portugal. However, that did not prevent FC Portugal to adapt its flexible strategy to that crowded type of defense and to easily score 6 or more goals and have lots of other scoring opportunities.

We believe that the Seattle simulation competition is going to finally be very much like a real soccer tournament. In Melbourne, the games between FC Portugal and Karlsruhe Brainstorms seemed just like real soccer games. Since, several teams made available their low level skills or even their complete source code we believe that at the low-level, the best teams are going to be very tight. At the team and individual level, intelligent perception and communication, SBSP and DPRE (or similar concepts) and marking techniques are surely going to be used by the best teams. Although the quality of the individual players (their low-level skills and mainly their individual decision making) will continue to be crucial, the winner of RoboCup 2001 will be most likely decided on the bench. The quality of offline and online coaches that define the team strategy and analyze the opponents, changing that strategy accordingly (different tactics, formations and player types), being one of the major distinctive factors! Just like in real soccer…

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