

## Intelligent Autonomous Agents ICS 606 / EE606 Fall 2011

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## RoboCup and Agent Soccer

- [www.robocup.org](http://www.robocup.org)
- <http://www.robocup2010.org/>

### ▪ Paper discussion –

The road to RoboCup 2050. Burkhard, H.D., Duhaut, D., Fujita, M., Lima, P., Murphy, R. and Rojas, R. Robotics & Automation Magazine, IEEE, Volume 9, Issue 2, June 2002 Page(s):31 – 38.

Online: IEEE digital library (UH)

## What is RoboCup?

- A consortium of companies and university researchers (non-profit)
- Create common test beds for artificial intelligence research, both
  - software (simulation) and
  - robotics (hardware)
- International workshop and competition every year since 1997
- Web page: [www.robocup.org](http://www.robocup.org)

## The Goal of RoboCup

"By mid-21st century (2050), a team of fully autonomous humanoid robot soccer players shall **win** a soccer game against the winner of the most recent World Cup, complying with the official rules of the FIFA."

--The Road to Robocup 2050 (2002)

- *Past Progress Brings Us Towards a Research Road Map for Further Competitions and Developments*

## Agent Soccer World Cup

- Intelligent programs play soccer against each other (simulation league)
- Intelligent robots play soccer against each other
  - Legged, middle size, and small size, and humanoid leagues
- World championship competition each year
  - Japan '97, France '98, Stockholm '99, Australia 2000, USA '01, Japan '02, Italy '03, Portugal '04, Osaka, '05, Bremen, Germany '06, Atlanta '07, Suzhou, China '08, Graz, Austria '09, Singapore '10 ...
- Videos from 2009 games:  
<http://www.robocup2009.org/306-0-video.html>

## The Agent Builders

- Typically groups of students, graduate students and professors from a university
  - Groups from 2 to 30 people
  - Collaboration between universities
  - Collaboration between universities and companies
- Teams come from all over the world: Australia, Africa, Asia, Europe, Japan, North America, South America, ..

### The RoboCup Soccer Leagues

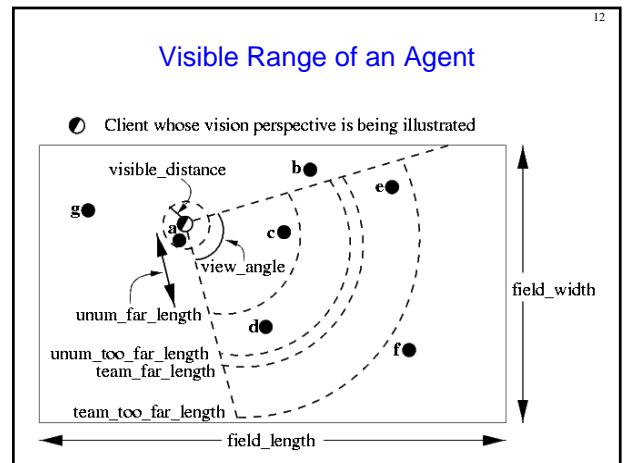
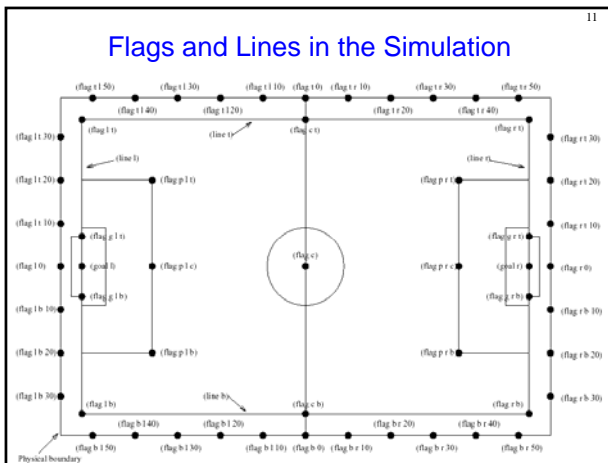
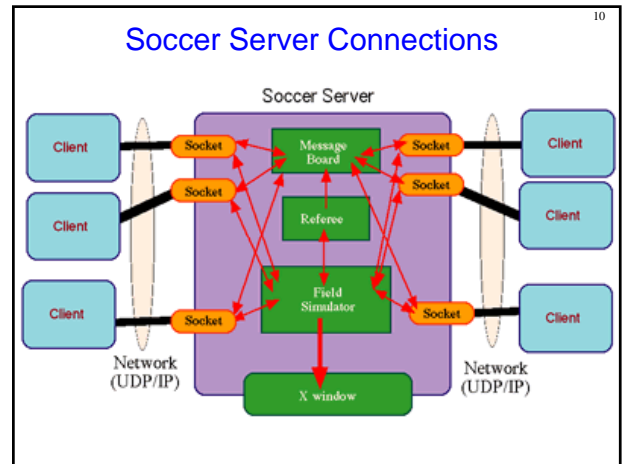
- **Simulation league (software)**
- Small size league (robots)
- Middle size league (robots)
- Humanoid league (robots)
- Standard platform league (robots) - was the Sony legged league
- <http://www.robocup2009.org/20-0-robocup-soccer.html>
- <http://www.robocup2010.org/>

### Simulation Soccer League

- All players are intelligent computer programs
  - 11 players vs. 11 players (+ 1 optional coach/team)
  - Each player communicates with the 'soccer server' via a network/the Internet
  - Follow standard rules for soccer
- Research focus
  - Co-ordination, learning, team strategies
  - Applications of results: simulators, space, real robots

### Soccer Servers 2D & 3D

- <http://www.robocup2009.org/212-0-general>



### AI Challenges in RoboCup Soccer <sup>13</sup>

- Learning challenge
- Teamwork challenge
- Opponent modeling challenge

### The Learning Challenge <sup>14</sup>

- Off-line skill learning by individual agents
- Off-line collaborative learning by teams of agents
- On-line skill and collaborative learning
- On-line learning of adversarial tactics

### The Teamwork Challenge <sup>15</sup>

- Contingent real-time planning for multi-agent adversarial game playing
- Plan decomposition and merging
- Executing team plans and re-planning

### The Opponent Modeling Challenge <sup>16</sup>

- On-line tracking of opponents
- On-line strategy recognition
- Off-line review of the effect of your strategies vs. your opponents'

### Agent Behavior Specification <sup>17</sup>

- Typically needs an AI/programming expert
- No higher-level behavior specification language
- The underlying agent control is done in the paradigm of the agents and in the programming language of the environment

### End User Strategy Specification for Soccer Players <sup>18</sup>

Whiteboard analogy

Create a player template

1. Draw a strategy
2. Test the strategy

Iterate as necessary for desired behavior

- Headless Chickens IV
  - By Paul Scerri, Nancy Reed, Tobias Wiren, Mikael Lonneberg and Pelle Nilsson

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### See Publications for Details

- **Layered Specification of Intelligent Agents.** Paul Scerri, Johan Y'dren, and Nancy E. Reed. In proceedings of the *Sixth Pacific Rim International Conference on Artificial Intelligence (PRICAI 2000)*, LNAI Vol. 1886, pages 565-575, Springer-Verlag, Berlin, 2000.
- **Headless Chickens IV.** Paul Scerri, Nancy Reed, Tobias Wiren, Mikael Lönneberg, and Pelle Nilsson. In P. Stone, T. Balch, and G. Kraetschmar, editors, *RoboCup-2000: Robot Soccer World Cup IV*, volume 2019, pages 493-496. Springer Verlag, Berlin, 2001.

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### Behavior Hierarchy

- Modular
- Layered
- Predicates
  - Fuzzy
  - Modifiers

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### Specification Language

- Keywords:
  - Play mode
    - Mode
  - Attributes
    - ATTR
  - Actions
    - Action
  - Parameters
    - Param

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### Strategy Creation Display

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### Example Strategy Design

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### Strategy Compilation

- Preloaded templates
- Extracts information
- Recursively builds the behavior structure

### Experience and Results 25

- Strategy editor enables users to quickly create complex coordinated behaviors
- Limited by the template
- HC teams competed in 4 world cups
  - 1st (1997) World Cup
    - 1 win 2 losses first round, 33 teams
  - 2nd (1998) World Cup, Paris, France
    - Reached quarter finals, 9th of 34 teams
  - 3rd (1999) World Cup, Stockholm, Sweden
    - Headless Chickens III, 5th out of 35 teams
  - 2000 Swedish Championships, May 9
    - Headless Chickens IV, *Swedish champions*
  - 4th (2000) World Cup, Melbourne, Australia
    - Headless Chickens IV + EASE, first round loss

### Thoughts: RoboCup Soccer Simulation League 26

- ‘Hacker’ teams no longer have a chance!
- Still the largest effort is in the hand coded parts
- Teamwork and strategies are necessary
- Learning is not only useful, but necessary!
- The simulation was too easy (increasing in difficulty each year)
- The communication is too powerful, noise added

### The Robocup Robot Soccer Leagues 27

- ”Intelligent” robots make their own decisions
  - No remote controls
  - Cameras view the world
  - Computers are the robot brains
- Differences between the leagues
  - Types and sizes of robots
  - Number of robots per team
  - Where the cameras are located
  - Where the computers are located

### The RoboCup Soccer Leagues 28

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### Small Sized Robot League 29

- Robots max size (18cm)<sup>3</sup>
- 5 robots per team
- Camera - Overhead (onboard allowed)
- Ball – orange golf ball
- Computer – all robots together (onboard OK)
  - Communicate with radio transmitters
- Research focus
  - Co-ordination, movement, vision, centralized decisions
  - Applications
    - Industrial robots, traffic monitoring, ...

### Middle Sized Robot League 30

- Robots: max 50 cm x 50 cm, 80 kg
  - Cameras, computers onboard the robot
- Max 4 robots per team
- Field : 10 m x 5 m
- Ball: size 5 orange soccer ball (FIFA)
- Research focus
  - Local vision, local intelligence, hardware integration
  - Applications
    - Military, search, household, tourguides, etc.

Friborg Robot - Laptop Onboard



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Legged Robot League

- Sony AIBO "dog" robots
- 4 robots per team
- Computing and vision onboard
- No additional sensors allowed
- Programmed with memory sticks
- Expensive!

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Legged Robots (AIBO 2001)



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Legged Robots (AIBO 2002)



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Legged Robots (AIBO 03)



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Standard Platform League (2009)



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### RoboCup Soccer Photos/Videos

- <http://www.robocup2009.org/108-0-gallery.html>
- <http://www.robocup2009.org/306-0-video.html>
- <http://www.robocup2009.org/20-0-robocup-soccer.html>
- <http://www.robocup2010.org/>

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### Agent Soccer Summary

- Standard test beds for working on complex problems
- Allow the direct comparison of alternative solution techniques to currently unsolved problems
- Simulation league has so far concentrated on higher level tasks (coordination and tactics)
- Robot leagues have concentrated on sensor interpretation (e.g. computer vision), sensor fusion, and system integration

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### For Further Information

- RoboCup organization  
<http://www.robocup.org>
- Association for the Advancement of Artificial Intelligence  
<http://www.aaai.org>
- Robocup soccer software:  
<http://sourceforge.net/projects/sserver/>

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