An Introduction to

RoboCup

and

Soccer Simulation 2D

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Overview of lecture

- Overview of RoboCup
- Necessity of Simulation Leagues
- Overview of 3D Simulation
- Simulator Mechanics
- Simulator Communications Protocol
- Some Existing Clients
- Other Developments/Tools

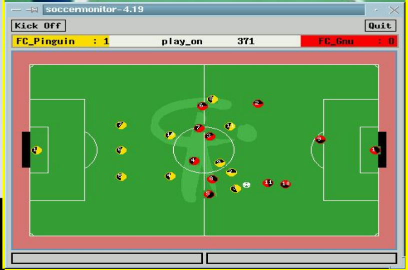
What is RoboCup?!

- The Robot World Cup Initiative
- Started in 1992 as the Robot J-League (Japan)
- First games and conferences in 1997
- Workshops, conferences and yearly competitions
- Slogan of games:
  - “By the year 2050, develop a team of fully autonomous humanoid robots that can win against the human world soccer champion team.”

The Goal of Robocup?

- RoboCup envisions a set of longer range challenges over next few decades
- A standard problem for research in:
  - Artificial Intelligence and Machine Learning
  - Machine Vision and Image Processing
  - Natural Language Processing
  - Multi-Agent Team Planning
  - And different challenges in Control and Electronics and Computer Science...

RoboCup Soccer Leagues

	Standard Platform
	Small Size
	Middle Size
	Simulation

soccermonitor-4.19

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Why Simulation?!

- Since it is not likely that the ultimate RoboCup goal will be met in the near future, it is important to also look for short-term objectives.
- The fact that no expensive hardware is needed to build the team.
- It provides a standard problem for the evaluation of various theories, algorithms and architectures.
- It abstracts from hardware issues and focuses on subjects such as skill learning, coordination techniques, and opponent modeling.
- It is much easier (and cheaper) to test a simulation team against different opponents.

Why Soccer?!

The most popular sport in the world

Two teams ⟺ Antagonism

11 players each ⟺ Distributed

Complexity ⟺ having a lot of conditions

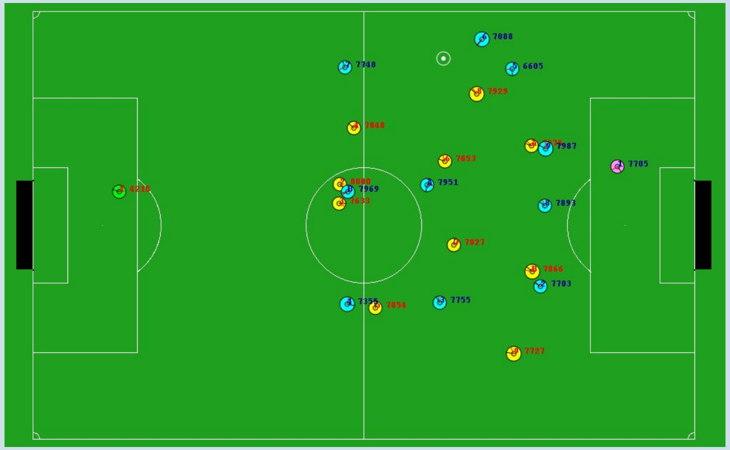
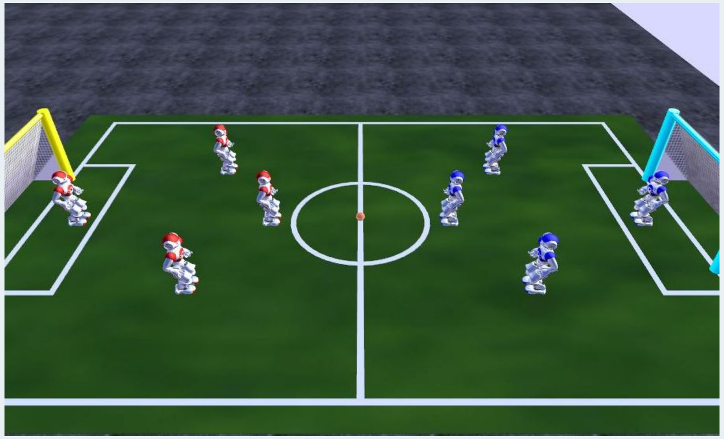
Uncertainty ⟺ Result of chaotic behaviour

RoboCup Soccer Simulation

A research and educational project for multi-agent systems and artificial intelligence.

The attempt to model a real-life situation on a computer so that it can be studied to see how the system works.

RoboCup Football Simulation Leagues

 7088 7748 6605 7929 7848 7987 7853 7705 4218 8000 7969 7951 7633 7893 7827 7866 7703 7355 7854 7755 7727	2D Simulation
	3D Simulation

RoboCup Simulation

Consists of:

- Server
- Monitor clients
- Player clients (i.e. agents!)
- Coach clients for each team

2D Soccer Simulation

Two teams of 11 virtual agents each play with each other.

based on a computer simulator (i.e. Soccer Server or RCSSServer) that provides a realistic simulation of soccer robot

One demonstrator software to show processes in graphical interface(i.e. Soccer Monitor or RCSSMonitor)

Each agent is a separate process that sends the simulation server.

Environmental information are send to each agent, after actions' occurrence based on noise values.

Why noise?

- Realistic
- [redacted]
- ....

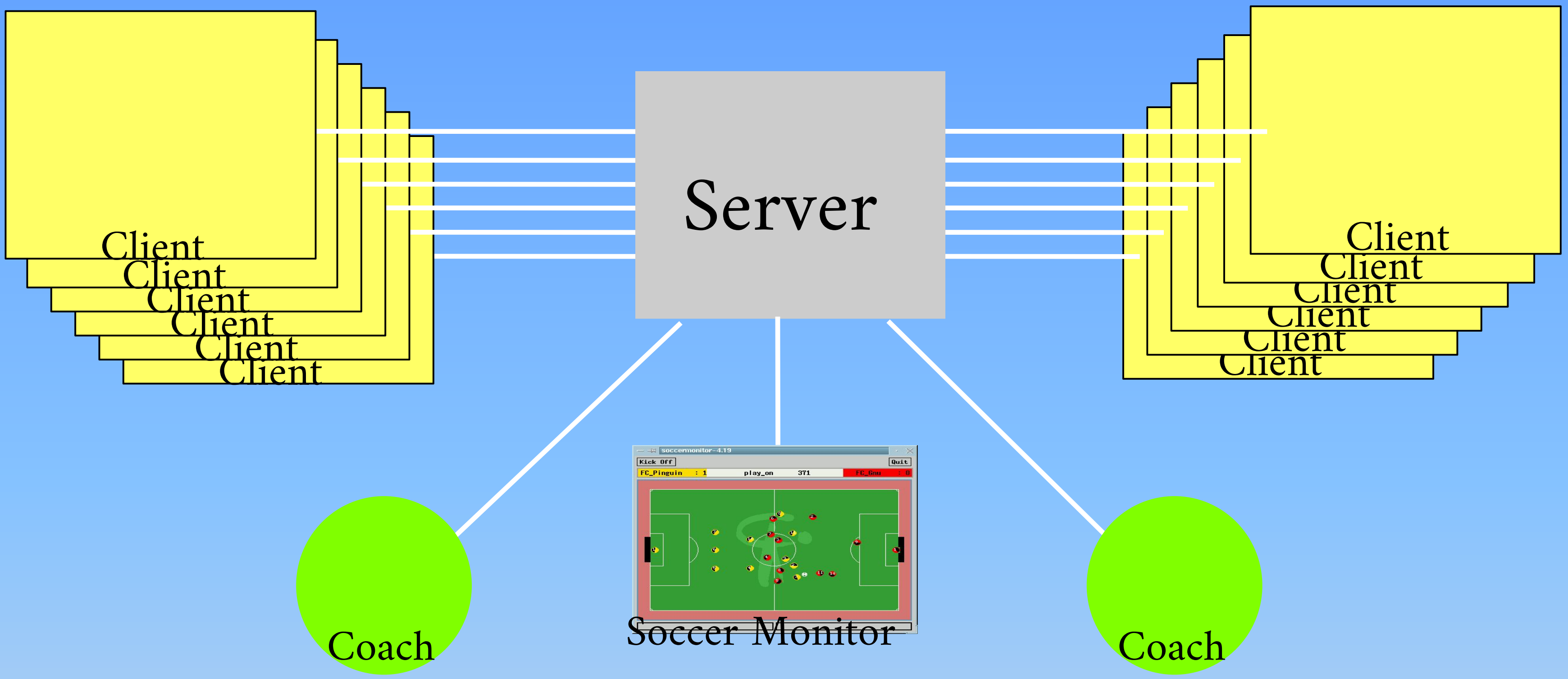
What is different from computer games?!

Goals

entertainment! Vs. research and education

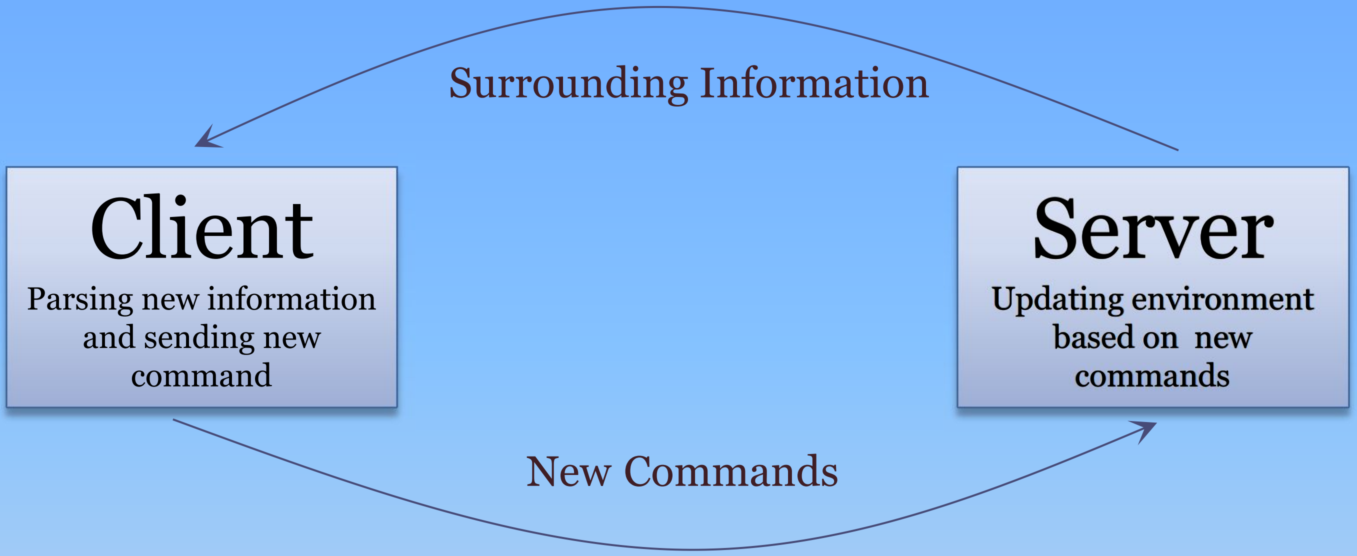
Differences in characteristics:

Reality
None-deterministic
Noisy
Partially observation
Continuous
Real time
Distributed
Practical



- Monitor(s) used to visualize the action and/or interrupt the game
- Coaches (optional) to give guidance to teams
- One server
- Up to 11 clients per team (plus one coach)
- [redacted]municate via UDP/IP
  - [redacted]port will be added soon!

Soccer Agents



Surrounding Information

Client

Parsing new information and sending new command

Server

Updating environment based on new commands

New Commands

- A cycle between server and clients :
- Sensory information received from server, decision made, action command sent back to server
- Clients may talk only to the server… not to each other!
- Clients' connection is just possible by restricted use of "Say Command"
- Clients; Autonomous agents
- One client represents one player, goalie or coach
- Clients can be written in any language (C++, Java, Smalltalk, …)
- [redacted] machine or a network

Clients

An agent is anything that can be viewed as perceiving its environment through sensors and acting upon that environment through effectors.

The outcome of actions is non-deterministic, consequently the agent has to learn a model for their prediction.

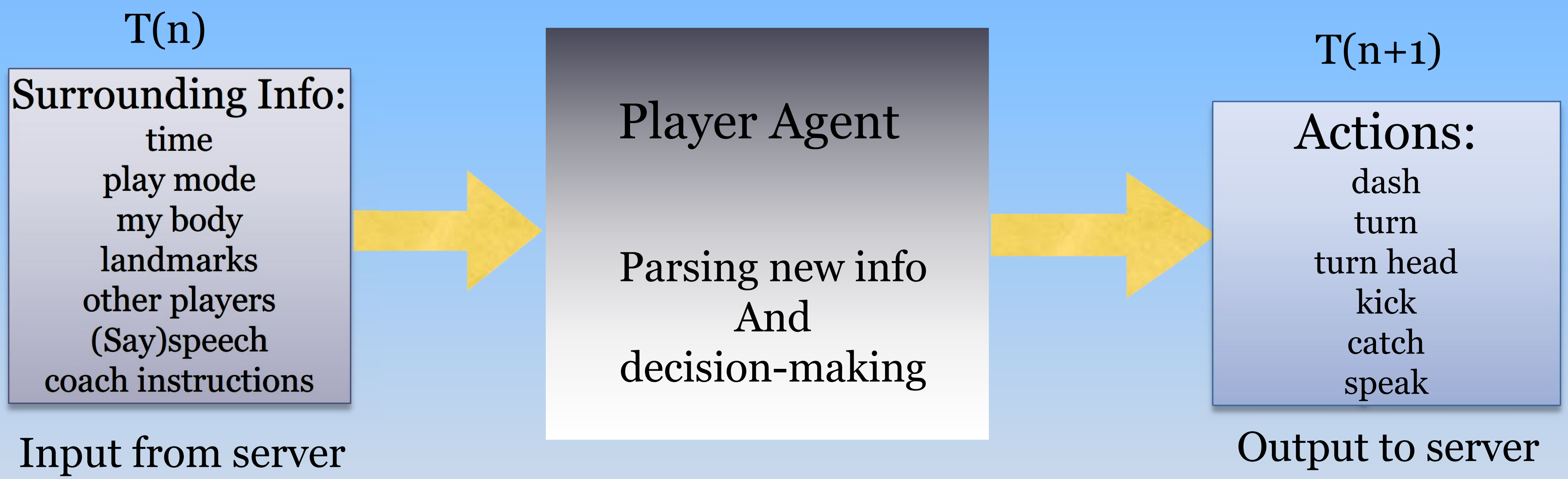
Observations are noisy and ambiguous, consequently the agent has to build an internal representation of the world, known as a “world model”.

The environment is dynamic, consequently the agent has to interact in real time.

The environment contains more than one agent, consequently the

r cooperate with other agents.

RoboCup Clients



T(n)

Surrounding Info:
time
play mode
my body
landmarks
other players
(Say)speech
coach instructions

Input from server

Player Agent

Parsing new info
And
decision-making

T(n+1)

Actions:
dash
turn
turn head
kick
catch
speak

Output to server

RoboCup Soccer Server

- Keeps time (typically 6000 simulator cycles, 10 cycles per second)
- Sends new status information
- Receives client messages and updates “world model”
- “Automated Referee” tracks current play mode

Coach Agent

- Privileged clients used to provide assistance
- Receives noise-free view of the whole field
- Used for opponent modeling, game analysis, giving strategic tips to teammates
- 1- Online Coach: Used to advise players during game
- 2- Offline Coach(Trainer): Used to train agent's in out of game time. This is an important tool for implement AI algorithms on one team.

Some RoboCup Source Codes

- Mersad(Iran)
- WrightEagle_BASE(China)
- UvA Trilearn (Amsterdam) (2003 champion)
- HELIOS (Japan)
- Agent2D (HELIOS_BASE)(Japan)

Typical Approaches

- Hard-coding (i.e. trial and error !)
- Layered Learning
- Reinforcement Learning
- Artificial Neural Networks
- Markov Decision Process
- Fuzzy methods
- …
- and combination of items above with together .

- Focus of implementations are also different :
  - Decision Making problem. (Cooperative, MAS)
  - Skill modeling (Individual or dual)
  - Opponent Modeling(e.g. about specific skill, cooperative task or positioning)
  - ….

Example: Krislet

- Only one strategy: run to the ball and try to kick it!
- Surprisingly effective: Some times it a good challenge for trained teams to test their algorithm’s effectiveness versus a stupid team!
- Written in Java, easy to extend

Example: Stripslet

- STRIPS style linear planning
- Written by Aloke Wiki
- Based off of Krislet
- A Stripslet implementation is made up of four main concepts: Actors, Sensors, Actions, and a GoalList

Example: UvA Trilearn

- Coordination Graphs for cooperative tasks e.g. passing, anticipating passing points
- Layered skills hierarchy (e.g. pass and intercept)

Example: FC Portugal

- Strategic, ball possession, ball recovery behaviours
- “Situation Based Strategic Positioning”
- Given game situation, calculated best position and go there

Example: Brainstormers

- Scientific research Vs. competitions
- Neural Modeling; Most off skills are written based on MLP.
- MDP-based decision making
- The best team in history of 2d league

Example: WrightEagle

- Neural Modeling
- Probabilistic approach to decision making
- Great offline noise modeling

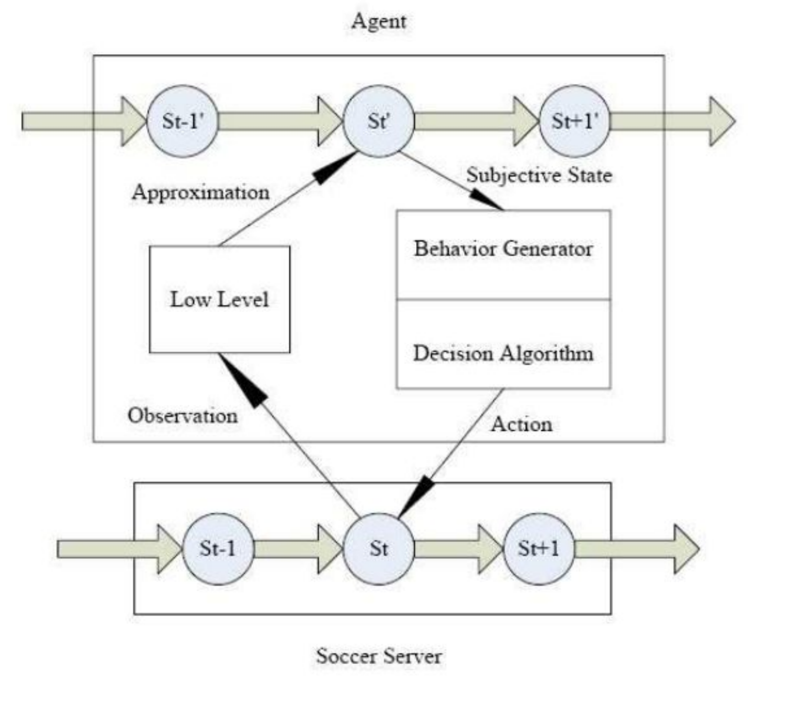
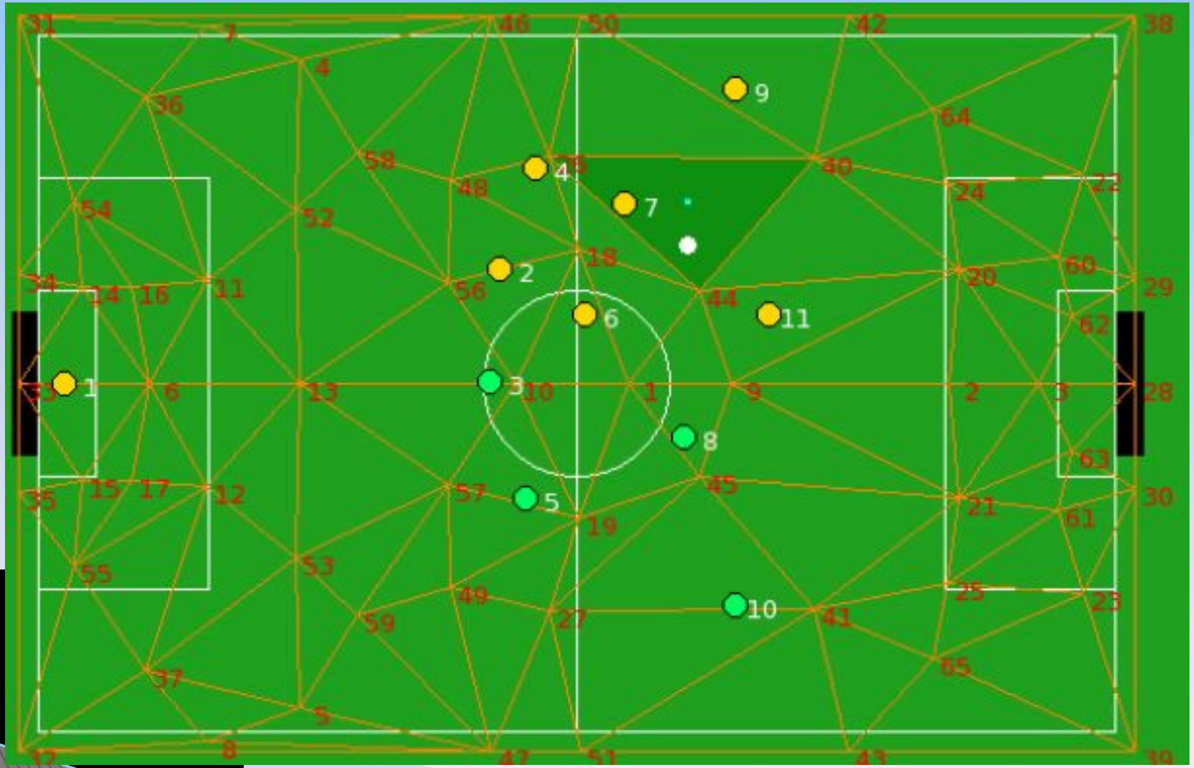


Fig. 1. Team Structure of WE2009

Example: HELIOS

- Most of team is hard coded and is result of experimental tests.
- The most heuristic part of this team is its semi-dynamic base positioning, based on Delaunay Triangulation. A local and fast function approximation.



Research On Soccer Simulation?!

Try to construct agents that are both autonomous and rational.
Autonomous implies that the agent makes its decisions without the guidance of a user.

Rational means that the agent selects those actions that are expected to achieve the best expected outcome based on the available information.

Research

Opponent Modeling

Modeling and reasoning about other agent's goals, plans, knowledge, capabilities, or emotions — is a key issue in multi-agent interaction.

On-line tracking Involves individual players' real-time, dynamic tracking of opponents' goals and intentions based on observations of actions.

On-line strategy recognition "Coach" agents for teams may observe a game from the sidelines, and understand the high-level strategies employed by the opposing team.

Off-line review "Expert" agents may observe the teams playing in an after-action review, to recognize the strenghts and weaknesses of the teams, and provide an expert commentary.

How do I join RoboCup?!

Knowledge

- Programming Language: C++(STL, boost), Script(bash, MATLAB, python...)
- Linux Operation
- Computer Algorithms, Artificial intelligence, ...
- Software Engineering

Starting a Game

- Download and install applications:
- RCSSServer : Main game running program. Teams connect to this module.
- RCSSMonitor : Visuliser of game.
- RCSSLogplayer: A tool for reviewing post game.
- (running the `configure` and make scripts for the Unix / Linux systems)
- Run the Server (default host is *localhost* and default port is *6000*)
- Run the Monitor, connecting to the host and port of the Server
- [redacted]ers to the Server host and port
- Start th[redacted]!

Read More?!

- About RoboCup: www.robocup.org
- Soccer Server Manual
- Robosina from scratch(Bachelor Thesis)
- Articles and TDPs of world cup teams

How To Start?!

- Start with UvA-Trilearn-Base:
  - Download: http://staff.science.uva.nl/~jellekok/robocup/2003/
- Compile it with `configure; make;`
- We will analyze different aspects of UvA-Trilearn-Base code next section

References

- Most of the information about RoboCup itself was taken using from the RoboCup Soccer Server manual.
- For the latest manuals and server versions, visit the RoboCup project website at: http://sourceforge.net/projects/sserver