CAP6671 Intelligent Systems

Lecture 10:

Robocup (Introduction)

Instructor: Dr. Gita Sukthankar
Email: gitars@eecs.ucf.edu
Schedule: T & Th 9:00-10:15am

Location: HEC 302
Office Hours (in HEC 232):
T & Th 10:30am-12

Homework (due Feb 19th)

- 1 page writeup of which competition domain that you are interested in working on
- Writeup should include:
  - Which domain
  - Research problem/approach that you are interested in working on
  - Relevant background sources for anything that you are proposing

Robocup

- Goal: by year 2050 develop a team that can win against the human world soccer champion team
- 3000 researchers in 39 countries; 321+ teams over all the leagues
- In addition to soccer playing there are spinoff leagues that deal with other robotic problems:
  - RoboCupRescue (discuss on Thurs)
  - Robocup@Home

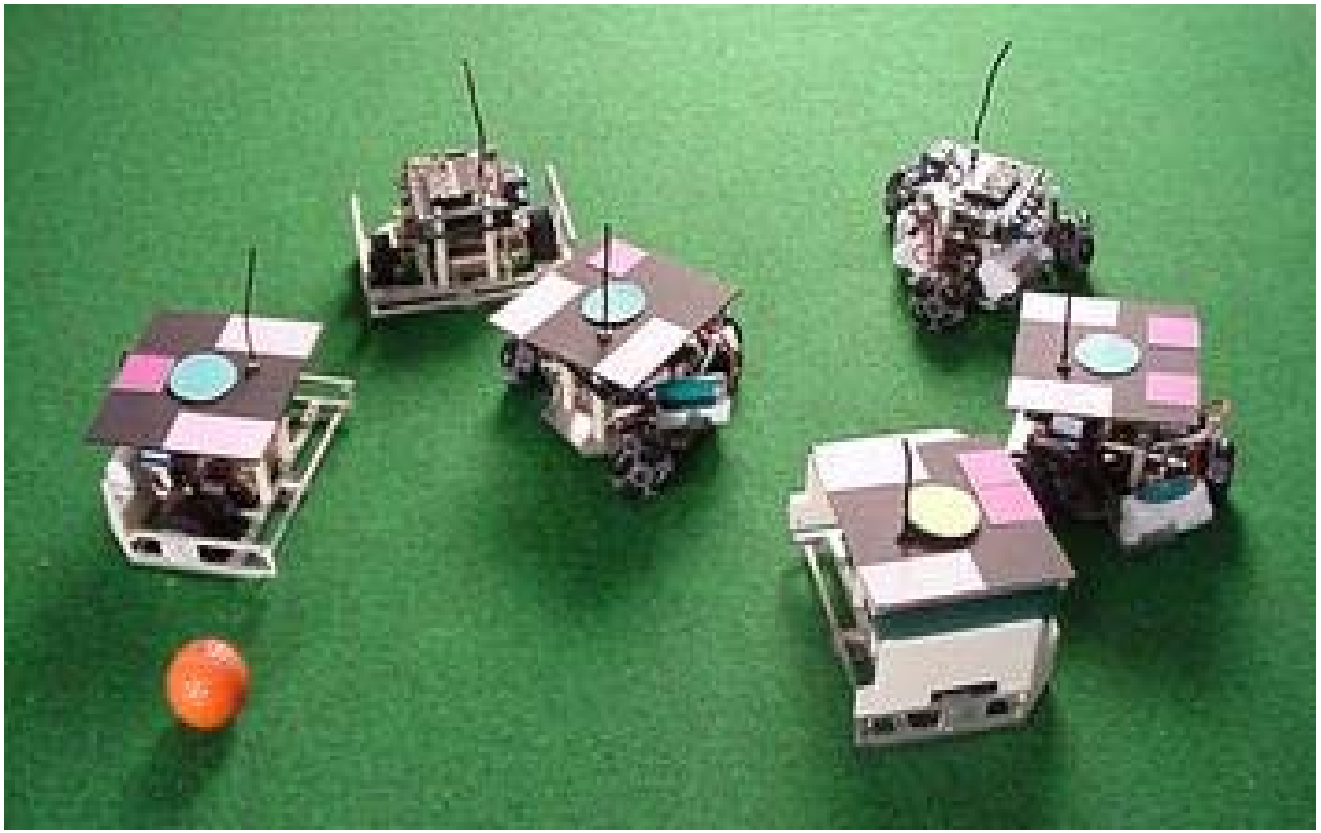
Research Challenges?

Research Challenges

- Real-time, dynamic environment
- Adversarial reasoning
- Incomplete information
- Rapid processing of visual data
- Distributed control/teamwork
- Legged locomotion (Aibo, Humanoid)
- Human-robot interaction (Segway)

Simulation League

Small Size League

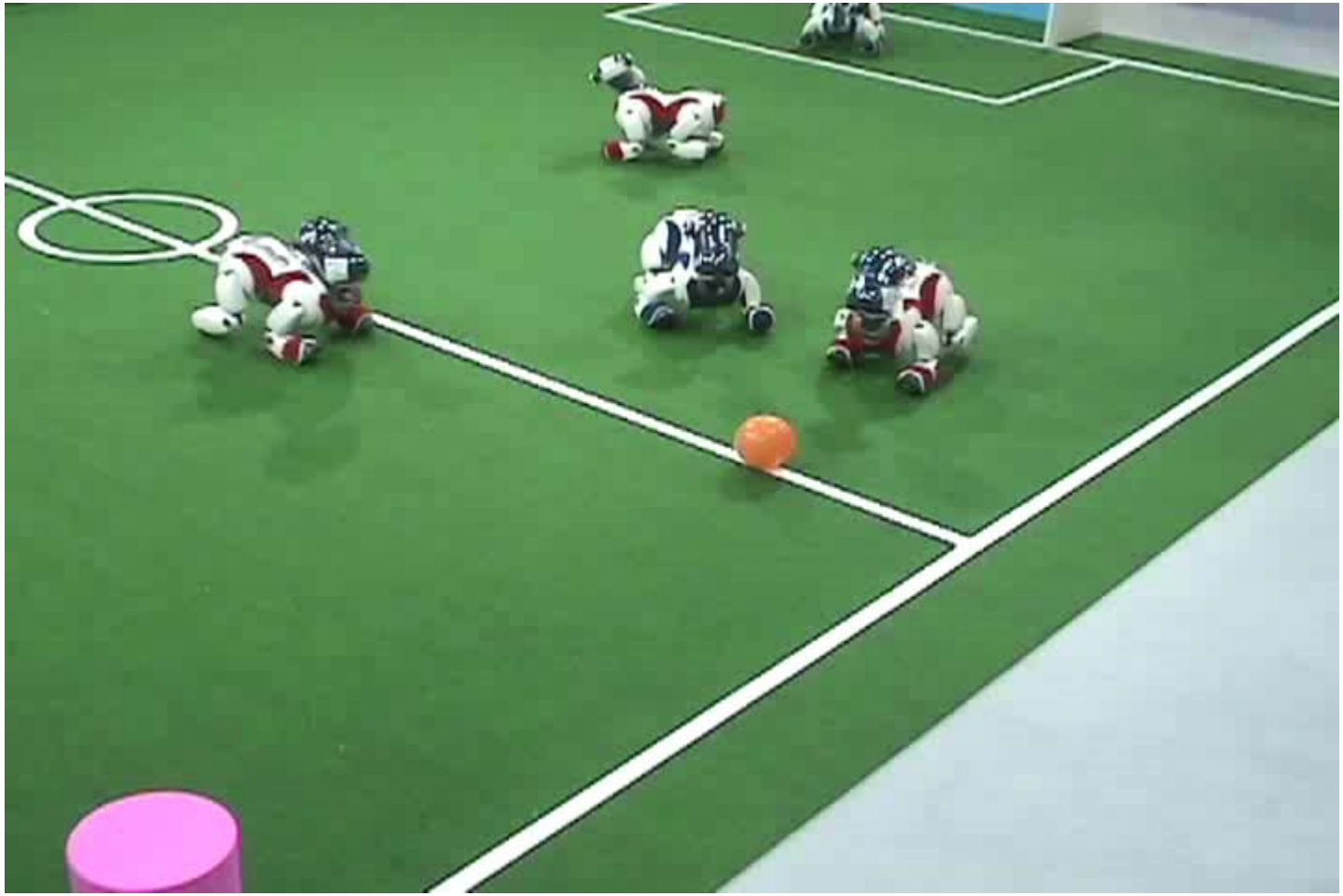


Small Size League

Mid Size League

4 Legged League (Aibo)

4 Legged League



Segway League

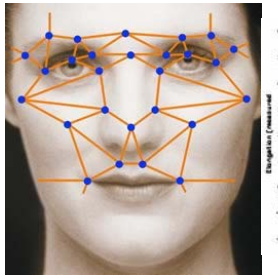
Segway League

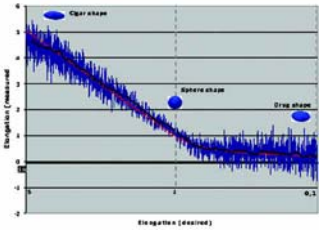
CMUnited-98 Overview

- Perception/cognition/action loop
- Updating world model/managing uncertainty
- Skills
- Coordination models
- Potential field models

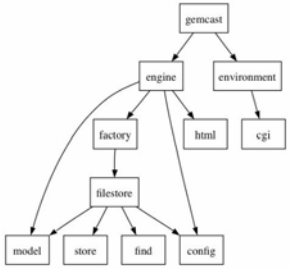
Perception-Cognition-Action

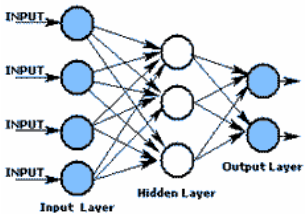
Camera
Sonar
Laser range-finders



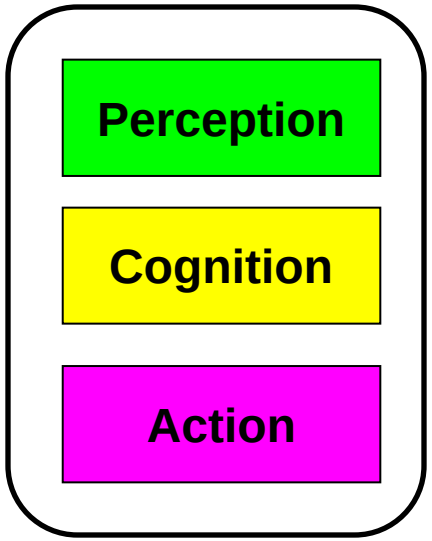


Planning
Scheduling
Machine Learning





Manipulation
Locomotion
Navigation



Updating World Model

- Global vs. local coordinate frame
- Objects are assigned confidence values
- Simulation domain is relatively easy compared to the leagues that use vision systems
- Vision systems need:
  - Rapid processing (usually color histogram based)
  - Robust ball tracking
  - To correctly orient the camera (for mid size/legged)

Robot's Perspective

Agent Skills

- Can make a significant difference to team performance
- Includes things: kicking, dribbling, interception, defending, clearing
- Principal challenge: not losing control of ball
- Note: simulator league models stamina to keep agents from running at full speed all the time
- PLOS model (Predictive Locally Optimal)
  - Use some form of prediction to decide on action
  - Execute first step of “plan”
  - Assume that you must replan at next time step

Locker-Room Agreement

- Designed for low-communication, time-critical adversarial environments
- Common problem: due to errors in the world model the robots misjudge the situation (e.g. 2 robots deciding that they are closest defender to the ball)
- Agents shift into different modes based on time, score, and game status which are guaranteed to be accurately known to all agents

Attraction/Repulsion Models

- Represent agent's policy as a potential field
- Objects in the environment exert attraction and repulsion forces
- Weighting forces creates different policies
- Drawback:
  - Potential minima possible (often solved by introducing randomness)
- Good points:
  - Really easy to implement

Other Research Problems

- Learning from data of previous games
  - TPOT-RL: system for learning to pass
  - Multi-task learning
- Coach league
  - How to recognize team/player behaviors
  - How to give agents advice to improve their game play
- Soccer specific subtasks
  - Evasion
  - Keepaway

Single Bots: HMM Approach

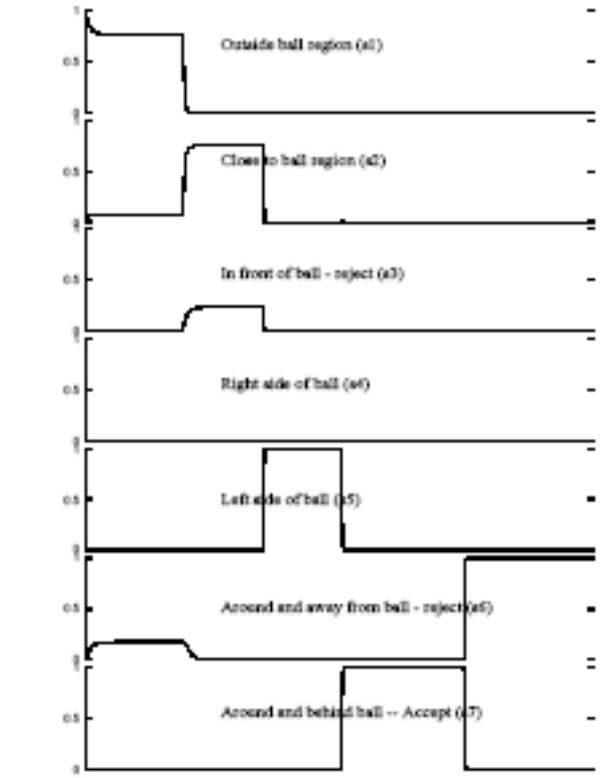


Figure 5: Go-Behind-Ball Behavior HMM probabilities

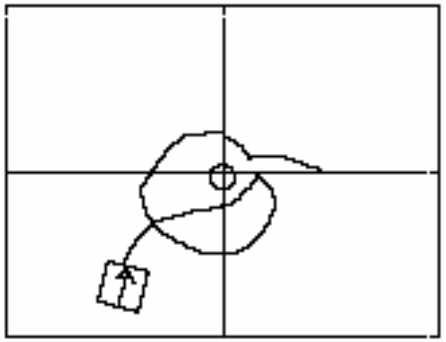
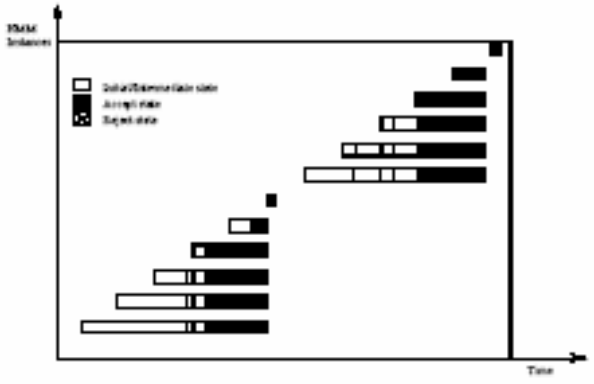


Figure 6: Robot Trajectory



(Han and Veloso, Automated Robot Behavior Recognition Applied to Robotic Soccer, 1999)

Coach League: Parametric Models

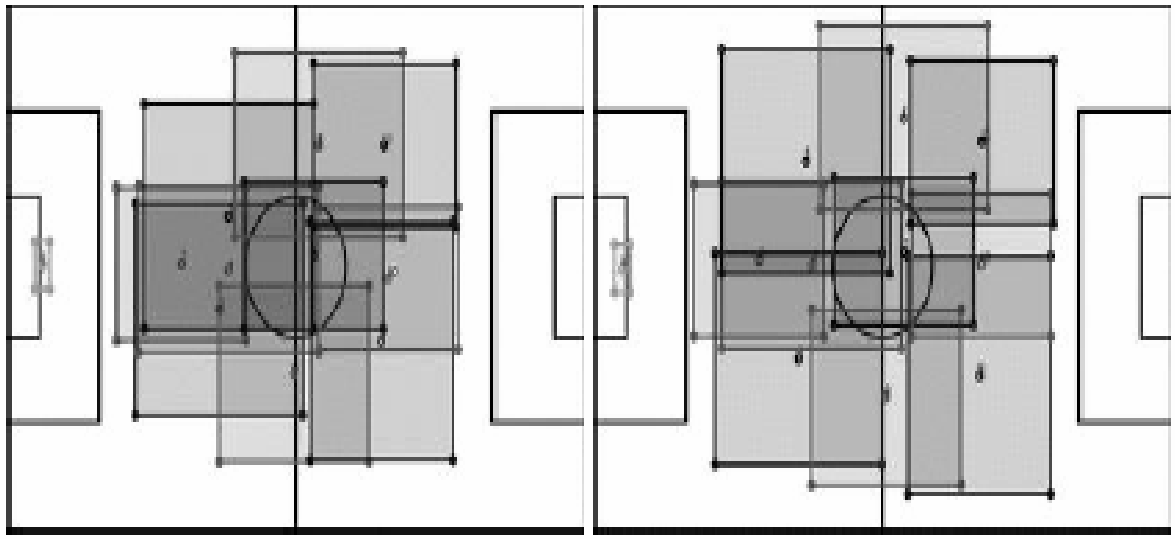


Fig. 1. The learning of the CMUnited99 formation from RoboCup2000 games.

(Riley, Veloso, Kaminka, An Empirical Study of Coaching, 2002)

(Kuhlmann, Knox, Stone, Know Thine Enemy: A Champion Robocup Coach Agent, 2006)

Detecting Team Failure with MBD

Model-based Diagnosis

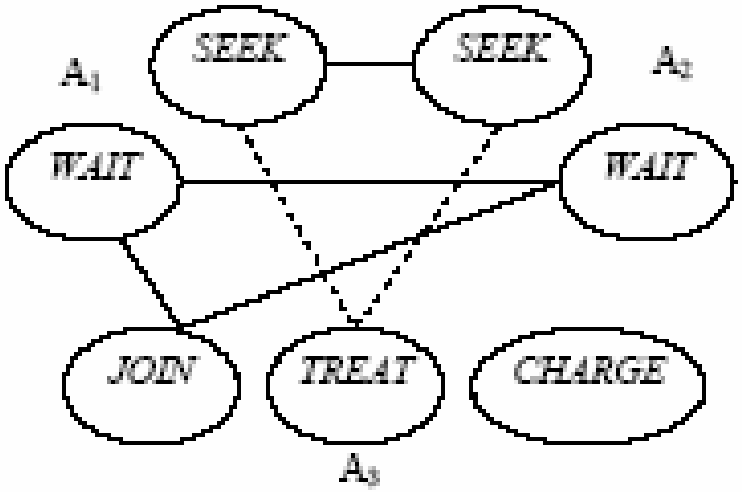


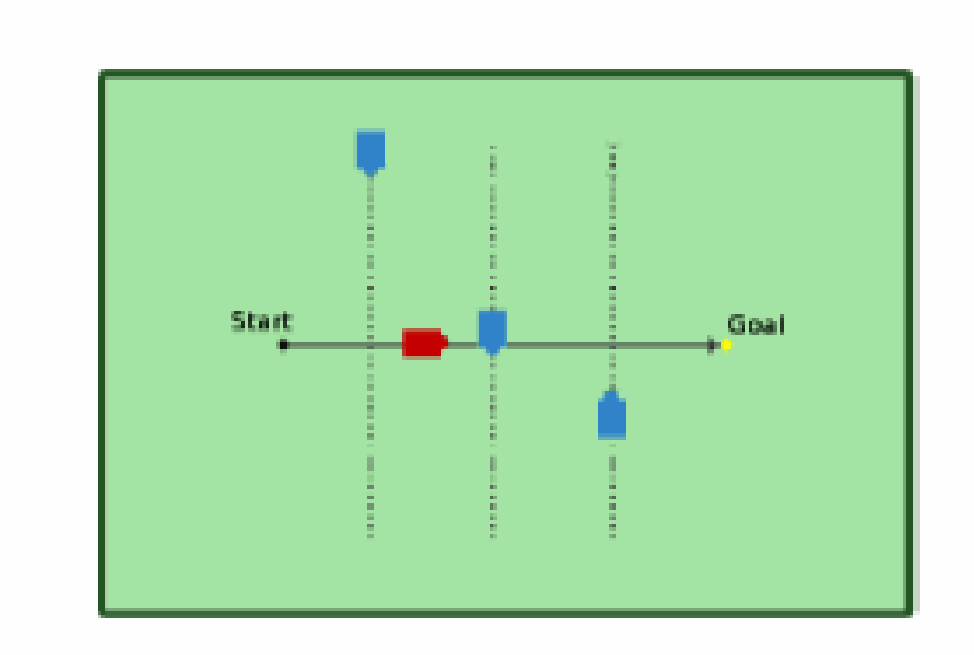
Figure 1: The coordination graph for team $\{A_1, A_2, A_3\}$.

(Kaminka and Tambe, Robust Agent Teams via Socially Attentive Monitoring, 2002)

(Kalech and Kaminka, Towards Model-Based Diagnosis of Coordination Failures, 2005)

RL Learning by Demonstration

3-Agent Evasion Problem



(Chernova and Veloso, Tree-based Policy Learning in Continuous Domains through Teaching by Demonstration, 2006)

Camera-Based Systems

Figure 5: Estimating the camera parameters by taking the current parameters, projecting the field model using the current parameters onto the image (left), finding the correspondences between model points and the imagepoints (middle), and adjusting the camera parameters to achieve minimal errors (right).

(Beetz et al., Computerized real-time analysis of football (soccer) games, 2005)

Summary

- Many interesting problems
- Different leagues highlight different research problems
- Criticism:
  - Robocup is a toy domain
  - Approaches are very “Robocup” specific