Courses on Robotics by Guest Lecturing at Balkan Countries

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With Great Thanks to all participating student teams and their institutes!

Courses on Balkan Countries *(2013-2016 founded by our program)*

2012	Ohrid	(funded as DAAD INTENSIVE COURSE "Robotics and Mathematics" together with Nevena Ackovska)
2013	*Novi Sad*	
	Rijeka	
	Sarajevo	
2014	*Plovdiv*	
	Rijeka	
2015	*Skopje*	
	Sarajevo	
2016	*Rijeka*	
	Tirana	
	Plovdiv: knowledge transfer to teaching staff	
2017	Rijeka	
2018	planned: Rijeka	(funded by Erasmus)

2017 Translation to Bulgarian Language

Courses in

- Plovdiv
- Burgas

Further courses:

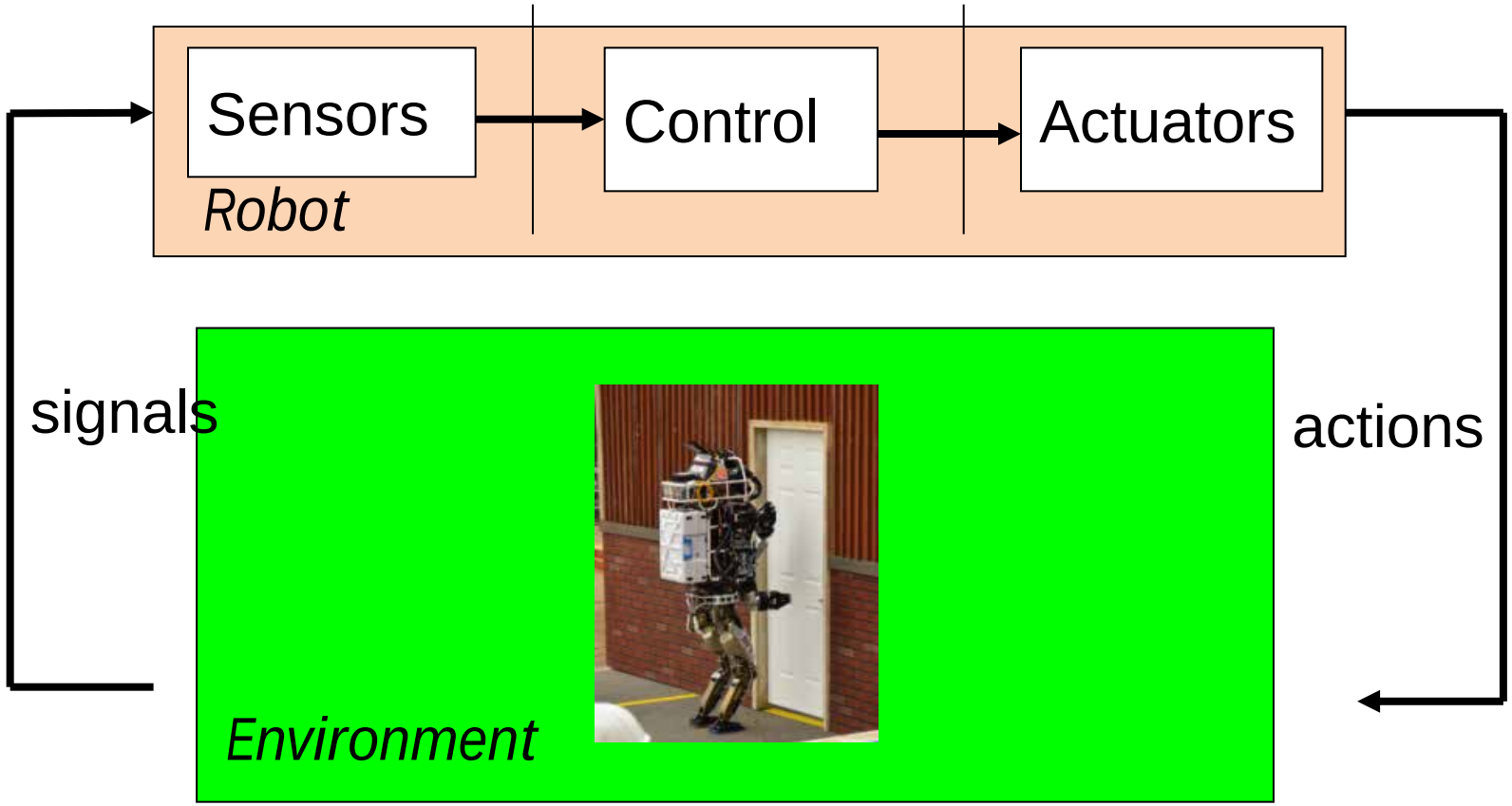
Poland:

- Vistula University Warsaw

Germany

- Humboldt University Berlin
- Anna-Seghers-Schule Berlin

Robot in the Real World



Robotics is an Integrative Task

- Software: Perception, Motion, Control, Communication, …
- Hardware: Sensors, Actuators, Processors, Energy, …

- Informatics, Artificial Intelligence, Physics, Mathematics, …
- Electronics, Mechanics, Materials, Design, Engineering, …
- Biology, Medicine, Sports, …
- Psychology, Philosophy, Sociology, …

Typical Duration of a course: 30 hours.

Up to 30 participants.

Lectures and exercises are mixed.

Topics of lectures:

- International Competitions (DARPA, RoboCup)
- Motion
- Sensors/Perception/World Models
- Behavior Control

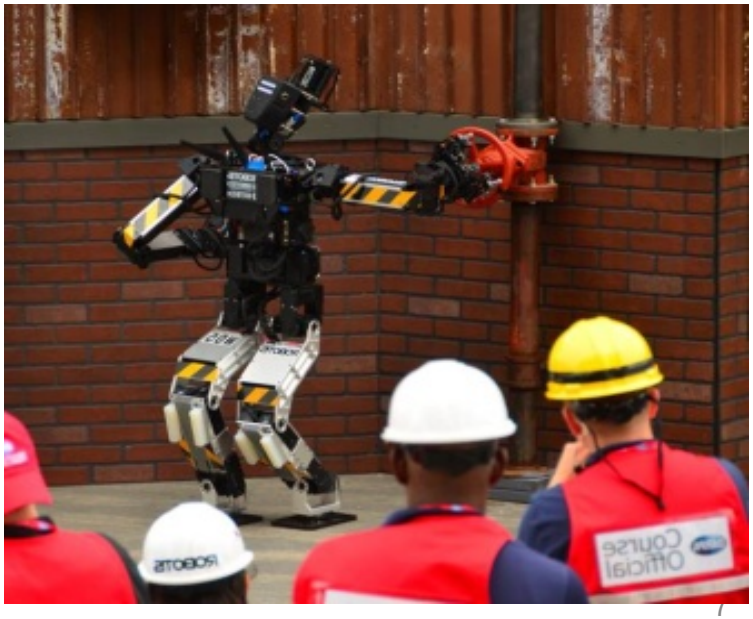
International Competitions: Illustration and exercises

DARPA Challenges

Autonomous Cars (2004-2007)

Robot Challenge

Desaster scenarios (2012-2015)



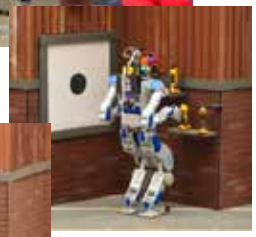
DARPA Robotocs Challenge

The robot

1. drives down an obstacle course,
2. dismounts the vehicle,
3. opens and goes through the door,
4. finds and closes a valve,
5. chooses a tool and carves out a hole,
6. solves the “surprise task” (e.g. plug a switch),
7. walks or climbs over some rubble,
8. climbs the outside stairs.





RoboCup: Soccer playing Robots as Testbed for Robotics and AI

Perception:

- Where are the ball, the goals, other players
- Where am I
- What are other players doing

Control:

- What should I do?
- Atacking, Defending, Supporting, ...
- Go to ball, Kick the ball (to which direction?)

Motion:

- Walk forward/sideward/backward, Turn, StandUp
- Kick, Catch, ...

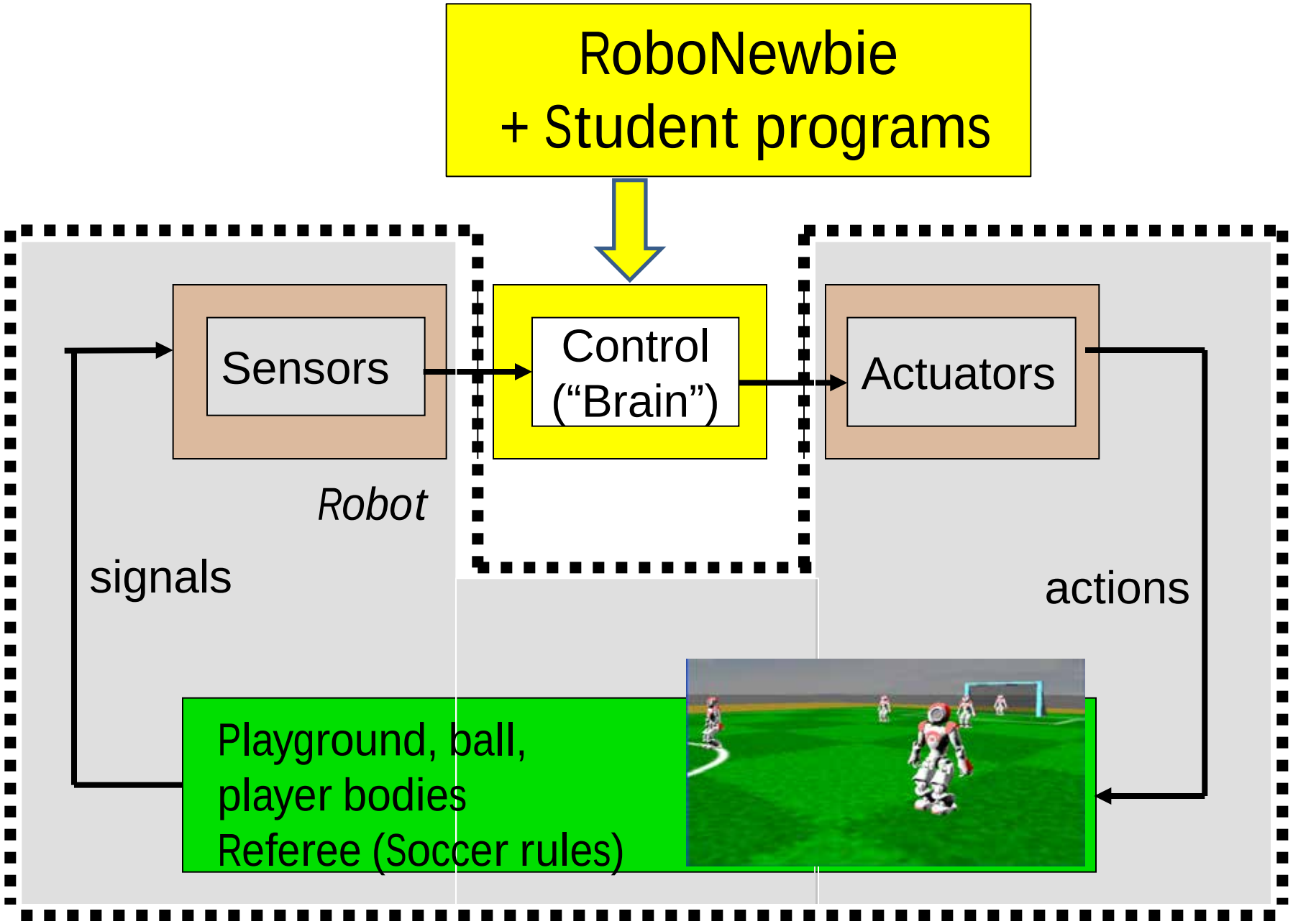
Exercises with Simulated Soccer Robots

Support for Programming by **RoboNewbie**

Diploma Thesis by Monika Domanska
at Humboldt University 2012

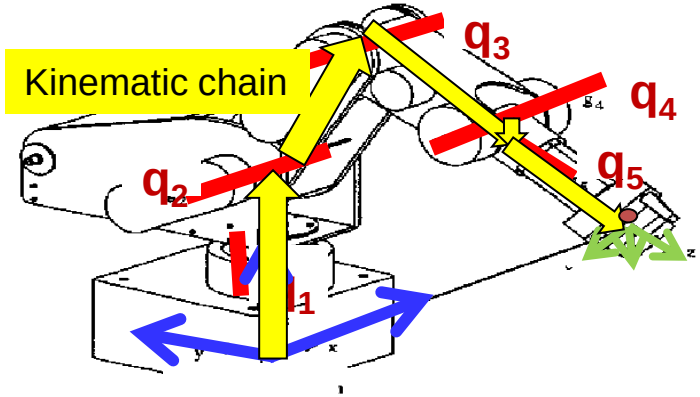
- Framework based on Java and Netbeans.
- Hides non-robotics aspects
  (e.g. communication with soccer simulation).
- Basic motion and perception.

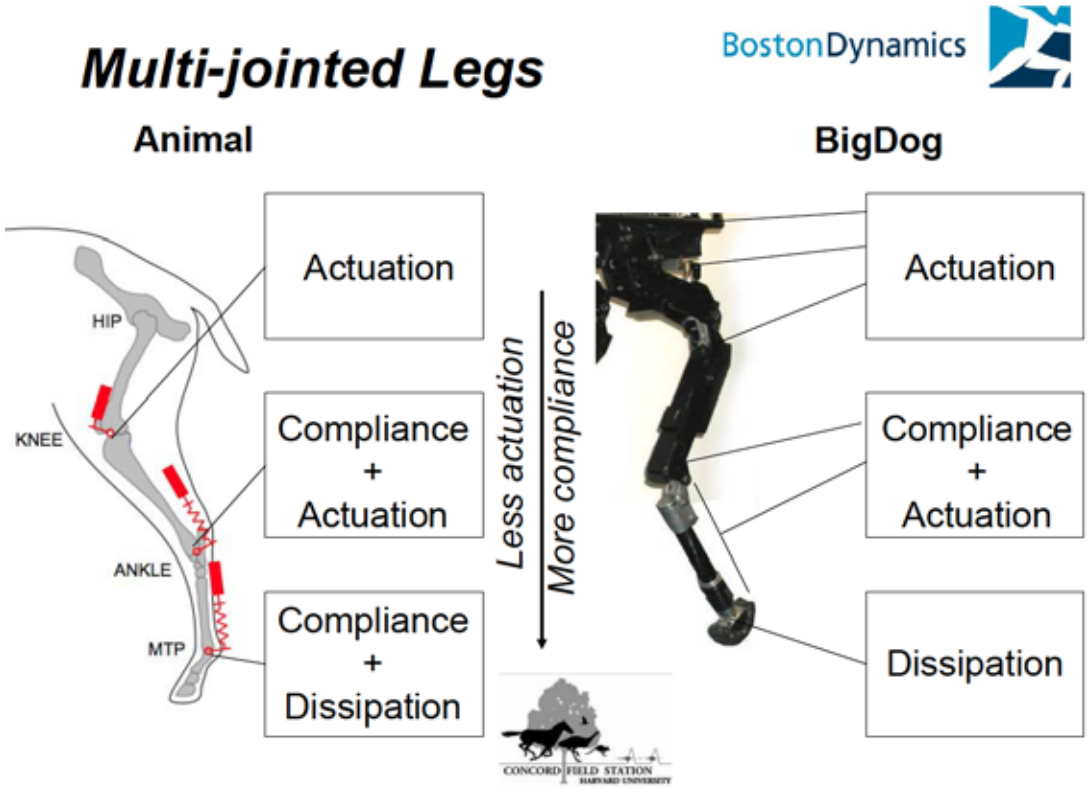
Download of all programs and materials from our website
http://www.naoteamhumboldt.de/projects/robonewbie/


RoboNewbie
+ Student programs
Sensors
Control
("Brain")
Actuators
Robot
signals
actions
Playground, ball,
player bodies
Referee (Soccer rules)

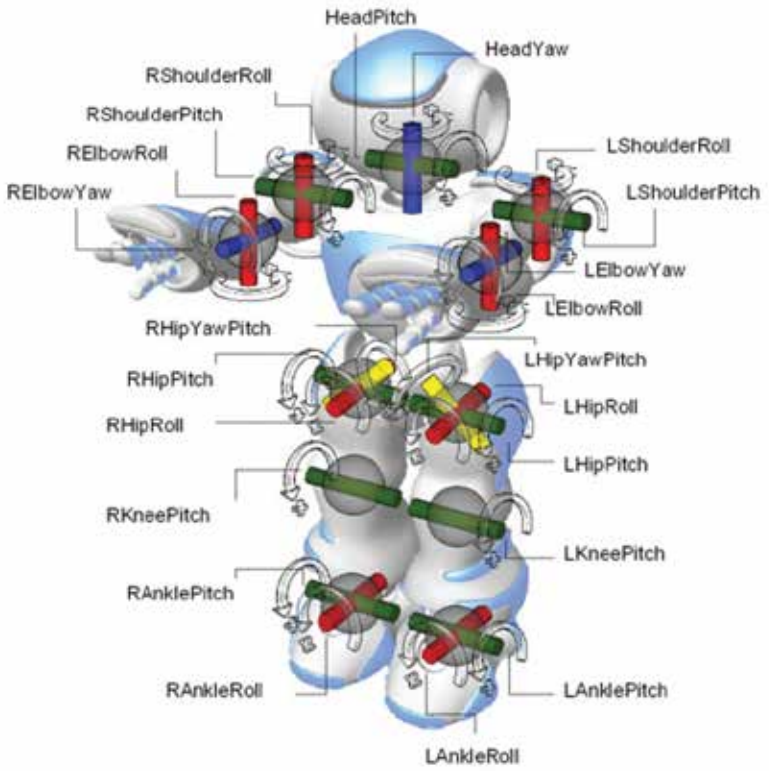
Motion

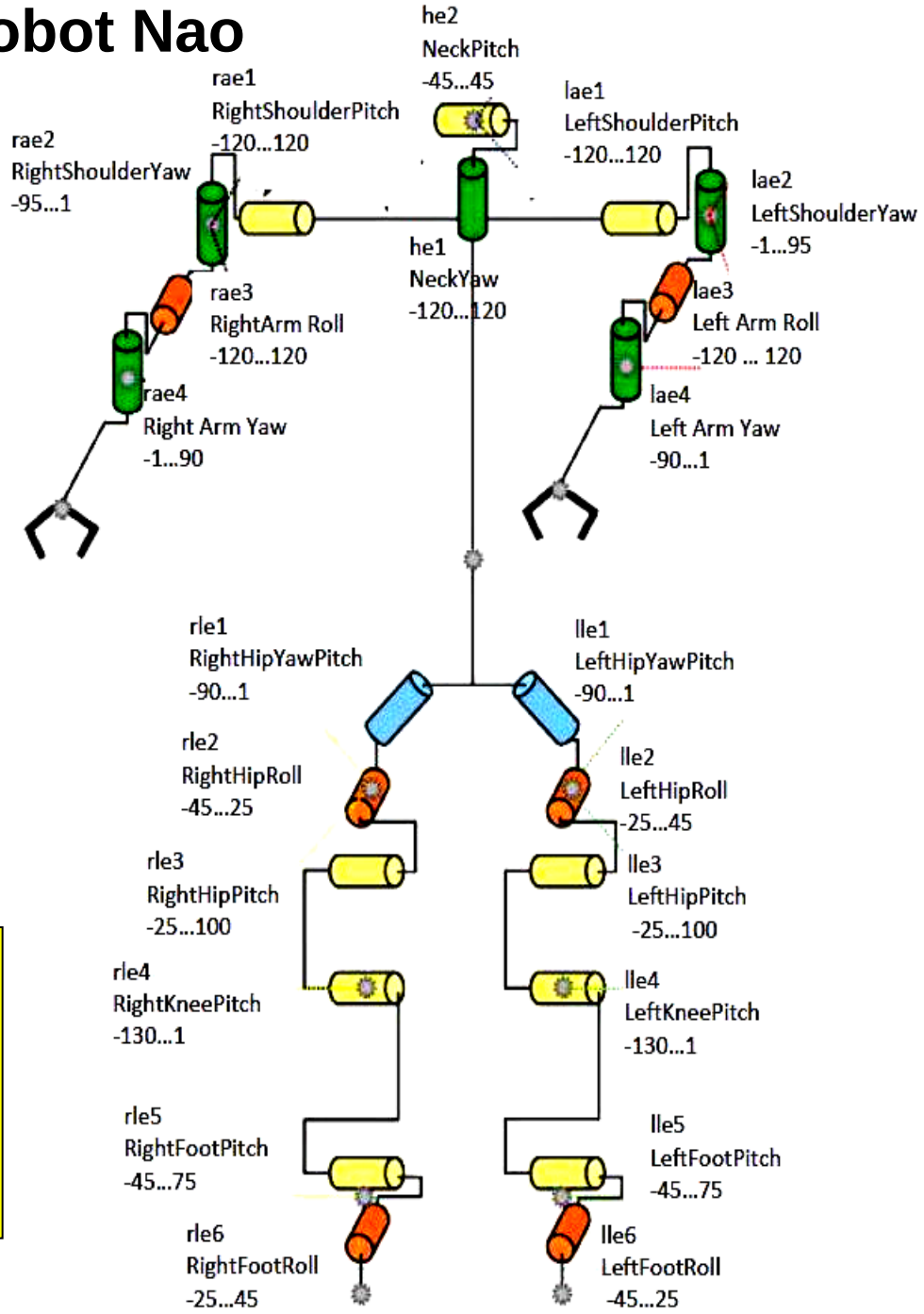
- Kinematics, Drive Systems,
- Legged Robots,
- Motion Planning and Control,
- Learning,
- Biologically Inspired Motions





Exercises with simulated robot Nao





22 joints
commands every 20 msec

1100 commands per second

First exercises: Implement knee bend, dancing, ...

Using setter methods from RoboNewbie, e.g.

```
effOut.setJointCommand(RobotConsts.LeftArmRoll,          2.3);
effOut.setJointCommand(RobotConsts.RightShoulderPitch, -2.0);
effOut.setJointCommand(RobotConsts.NeckYaw,              0.0);
```

for direct control of motor speed.

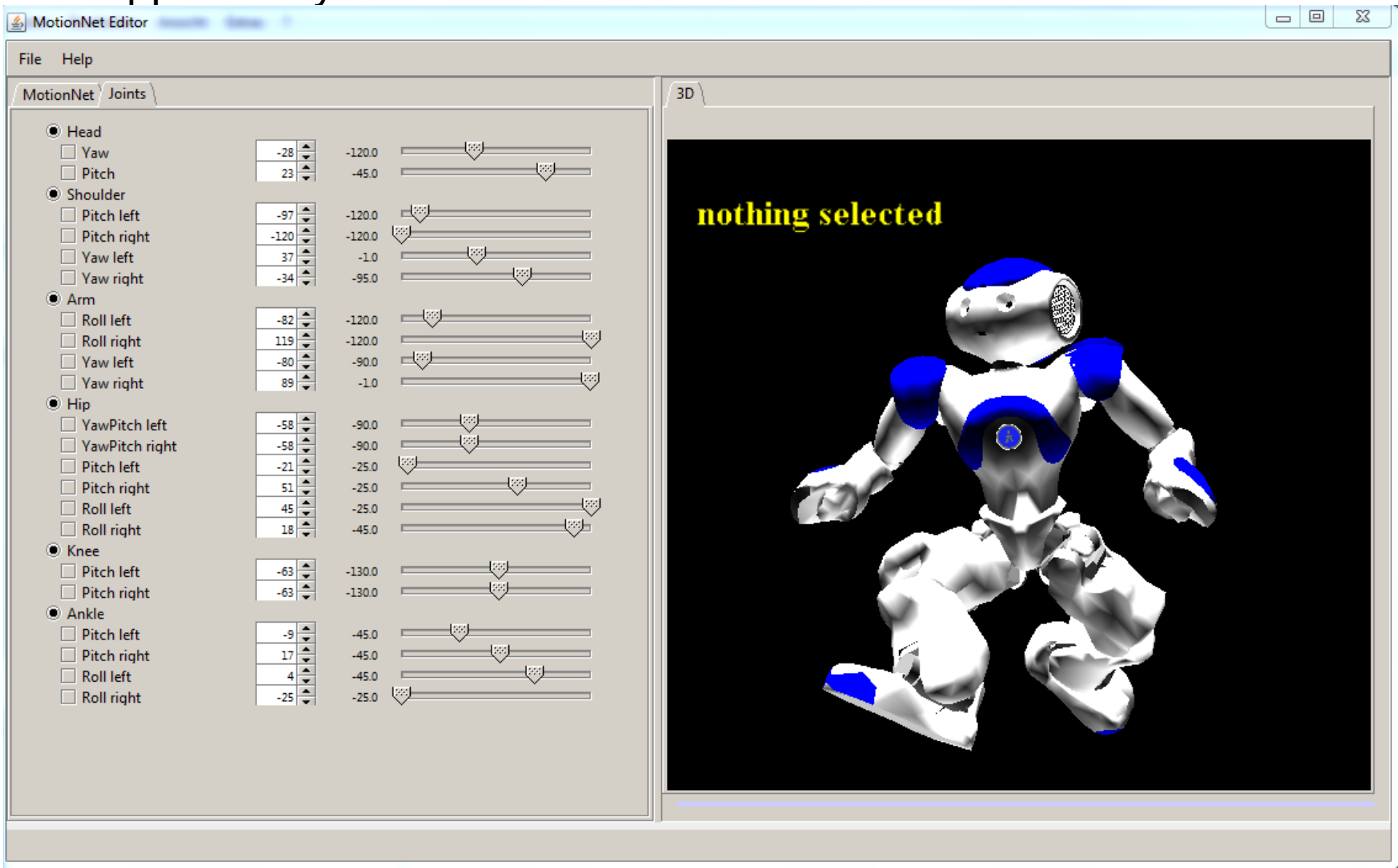
Problem: up to 22 commands every 20 msec

Keyframe techniques:

Define characteristic postures and let the robot interpolate between them

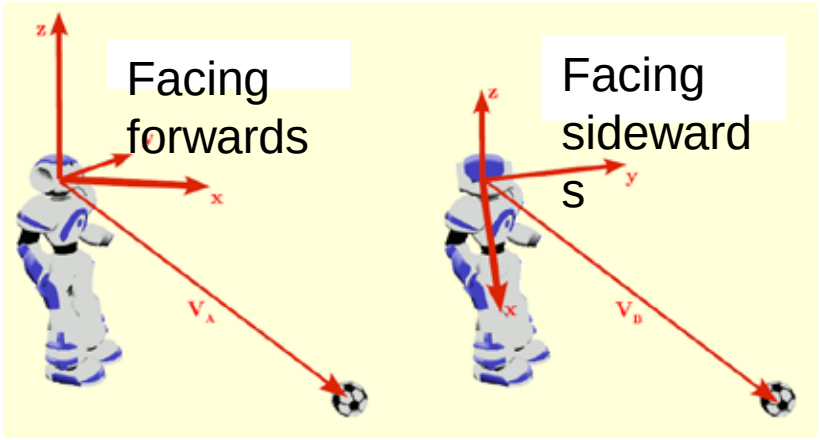
Motion exercises continued:

Keyframes for Walk, Turn, Kick, Catch, ...
supported by Motion Editor



Sensors/Perception

- Sensor types
- Vision/Camera Model, Interpretation, no image processing



- World Models
- Representations, Probabilistic Methods, Monte Carlo Methods

Perceptors in Simulation

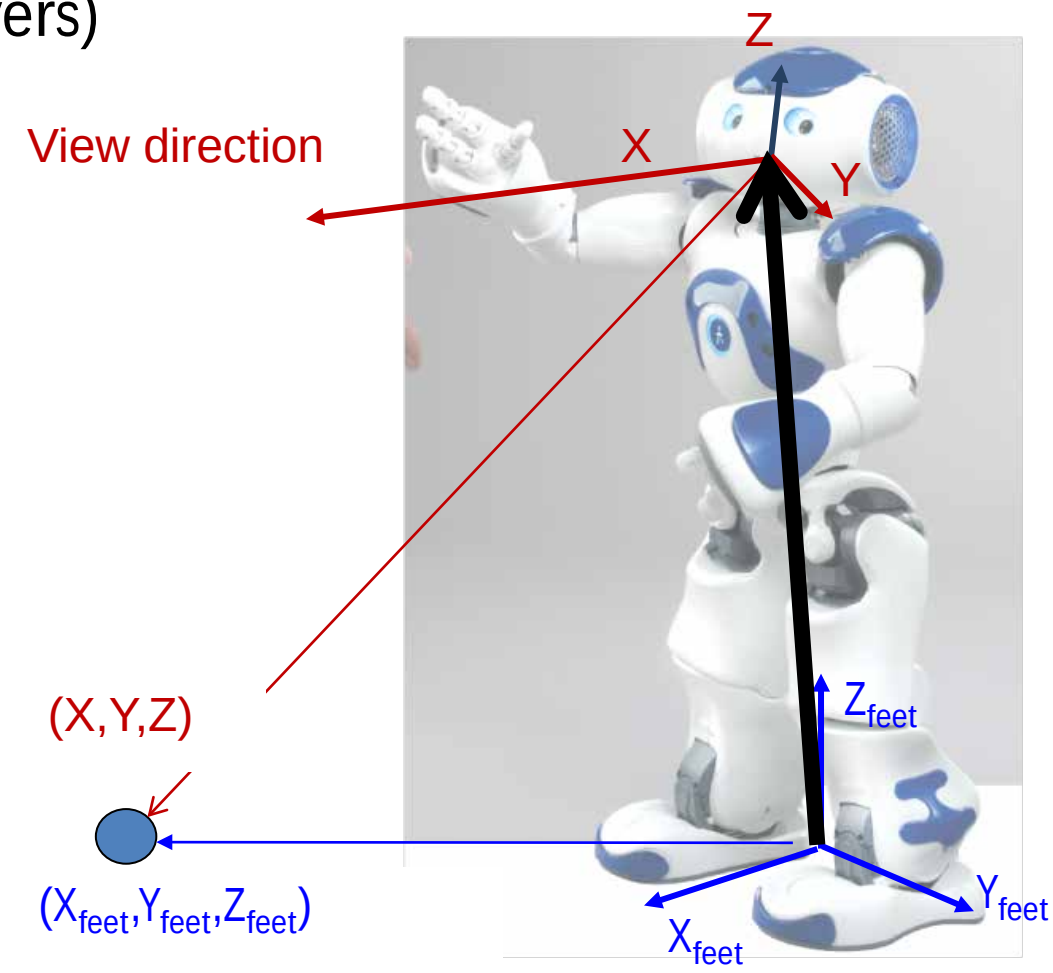
- Joint perceptors
- Camera at the head
- ...

RoboNewbie provides getter methods for perceptor data

*percIn.getJoint(RobotConsts.**LeftShoulderPitch**);*
*percIn.getGoalPost(FieldConsts.**GoalPostID.G2L**);*
*percIn.getBodyPart(PlayerVisionPerceptor.BodyPart.**llowerarm**);*

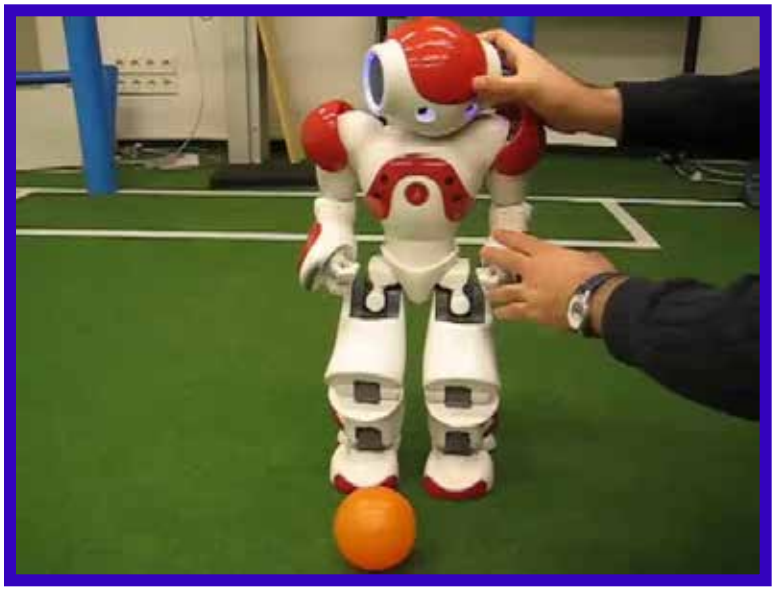
Exercises for perception:

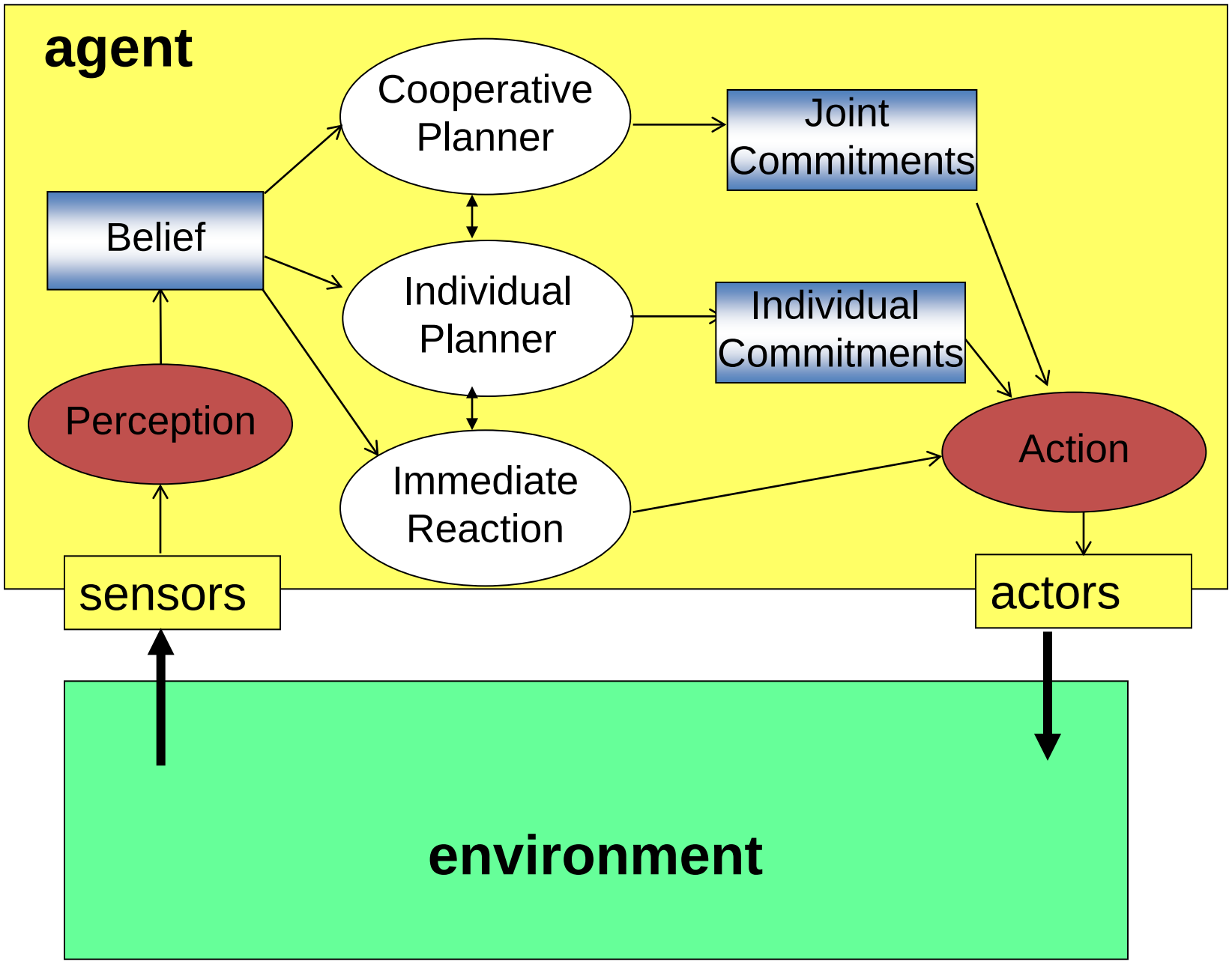
- Where is the ball
- Where are the goals
- (Where are the other players)
- (Where am I on the field)



Behavior Control

- Agent Architectures, e.g. BDI-approach
- Rationality,
- Behavior Based Robotics
- Sensor actor coupling

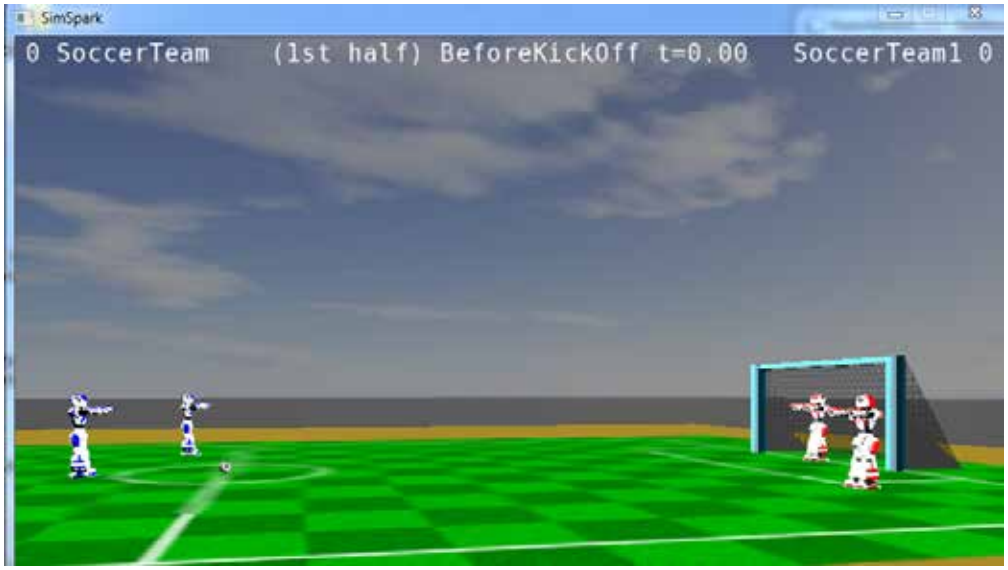



agent
Cooperative Planner
Joint Commitments
Belief
Individual Planner
Individual Commitments
Perception
Action
Immediate Reaction
sensors
actors
environment

Exercises for integrating perception, motion and control:

Implement a soccer team by joint work in groups of 4-5 students

Competition at the end of the course



Very Simple program:

```
Repeat:
    If robot has fallen down: Stand up
    If position of ball is not known:
        Search for ball by turning head (and body)
    else if if ball is far away: turn to ball, walk to ball
    else if ball not between player and goal: turn around ball
    else  walk forward („dribbling“)
```

Improvements;

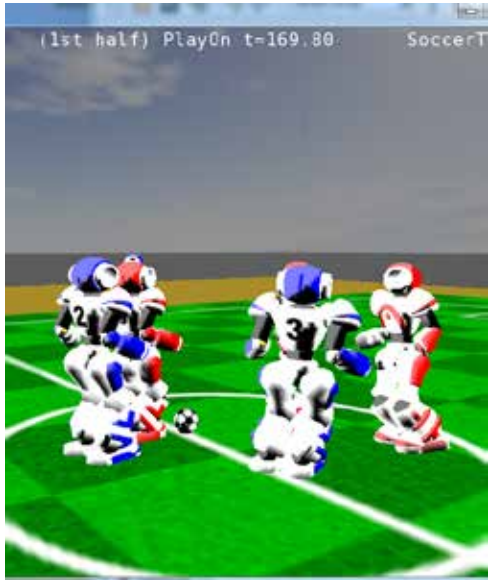
- Better skills: walk, turn, kick, catch, …
- Different roles: goalkeeper, attacker, supporter, defender

Different kinds of competitions over the years

- Fastest scoring (2012-2013)
- Matches 4 by 4 (2014)
- Matches 1 by 1 (2015)
- Matches 2 by 2 (since 2015)

Problem with too many players:

Crowding around the ball



Actual rules for games 2 by 2

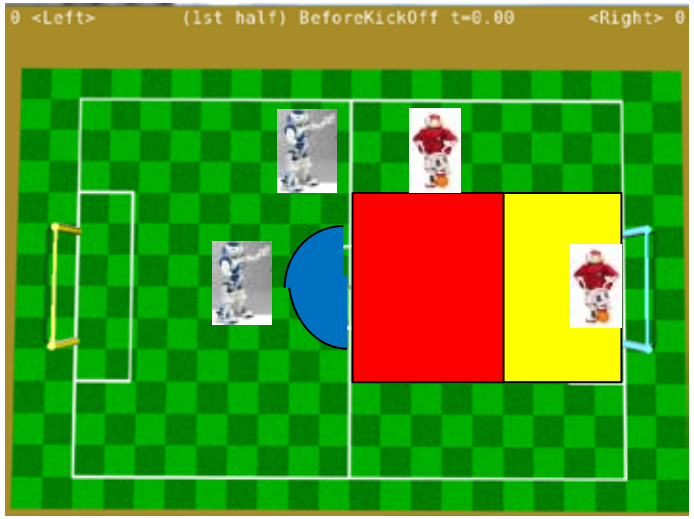
Offending team (left team with kick-off):

- Both players outside of the blue area

Defending team (right team)

- Player 1: outside of read area (goalkeeper)
- Player 2: outside of red and yellow areas

2 times 2 minutes, with change at half time



Last competitions in our DAAD program:

Rijeka 2016



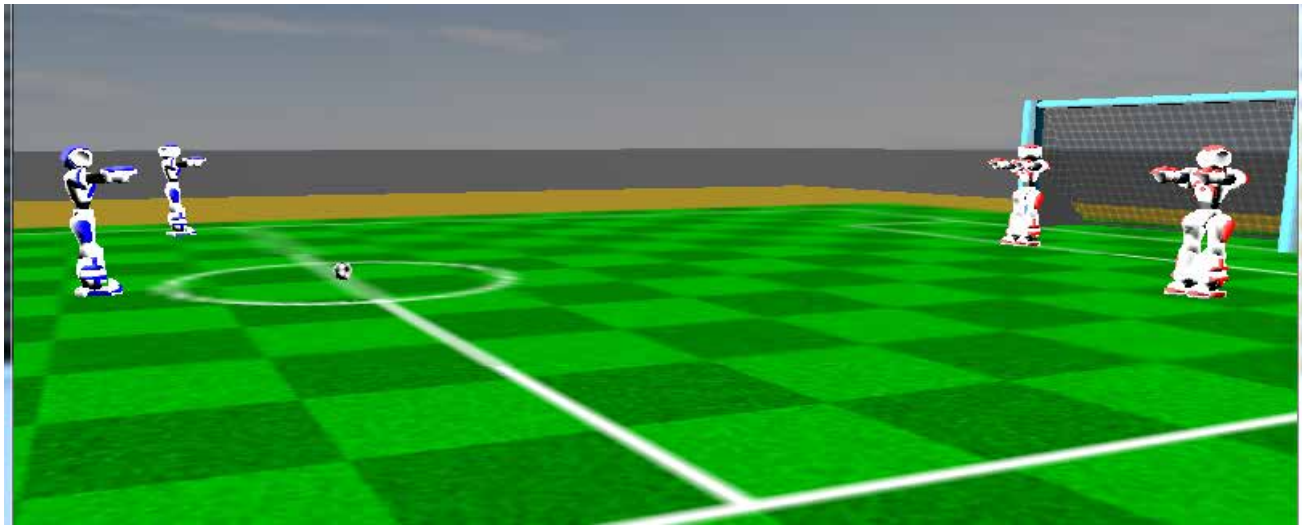
Tirana 2016

Example of a match (only one half)

Champions from Tirana 2016: RockinRobos
as offending team (blue)

vs.

Champions from Rijeka 2016: Hertha Berlin
as defending team (red)



Opinions of students:

Like the work with RoboNewbie. Want more time for exercises.

Need for better cooperative play:

Better skills for motions (omnidirectional walking).

Need for methods from Machine Learning.

Problem: 30 hours on 8 days are not sufficient.

Project in Plovdiv

Forthcoming paper by *A.Toskova*:

A Java Module for Humanoid Robot Self-Learning

Thank you!

You are invited to the next RoboCup Competition: