15-491 – CMRoboBits: Creating Intelligent Robots
Introduction

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Fall 2008

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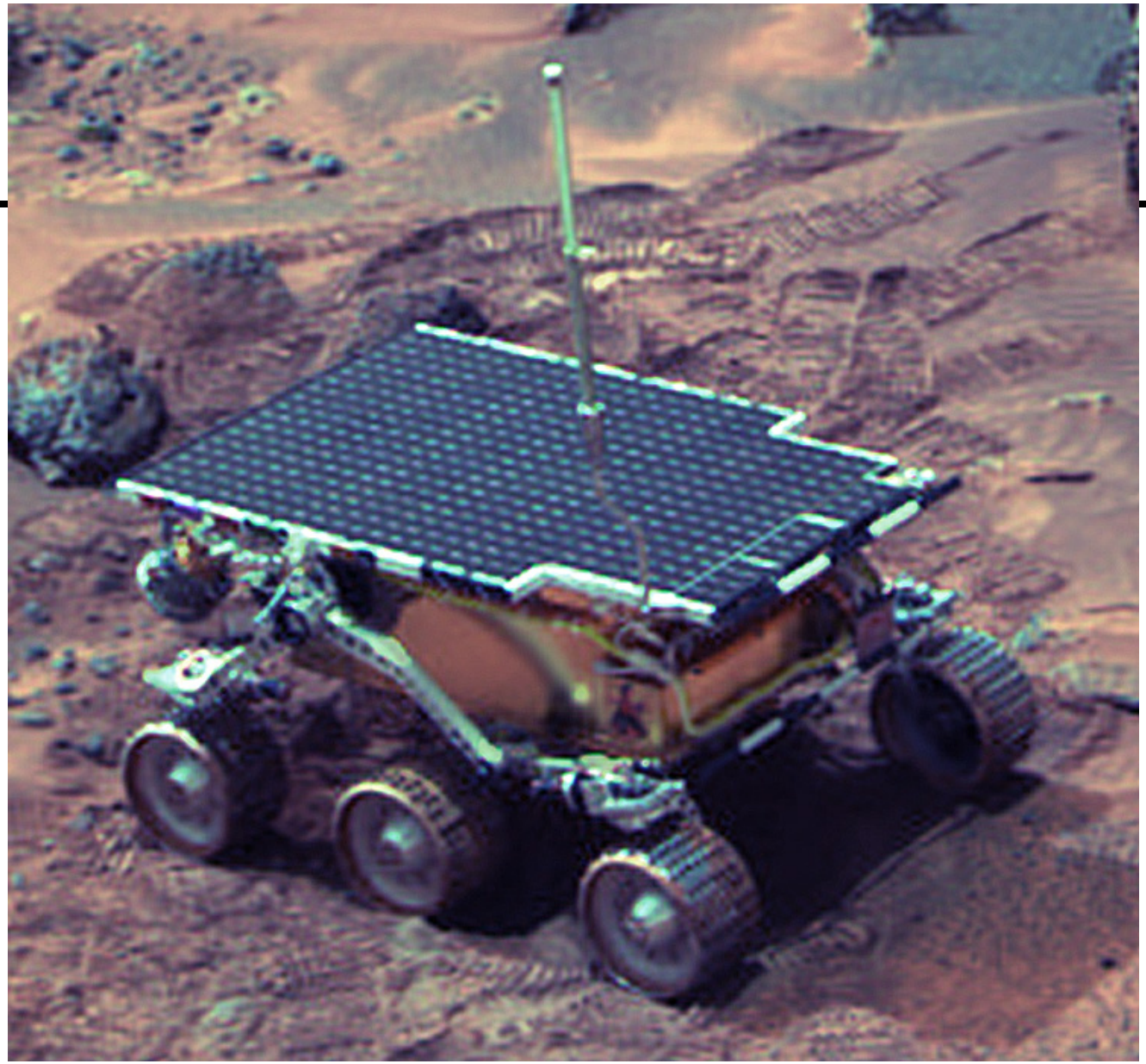
http://www.andrew.cmu.edu/course/15-491

Computer Science Department

Carnegie Mellon

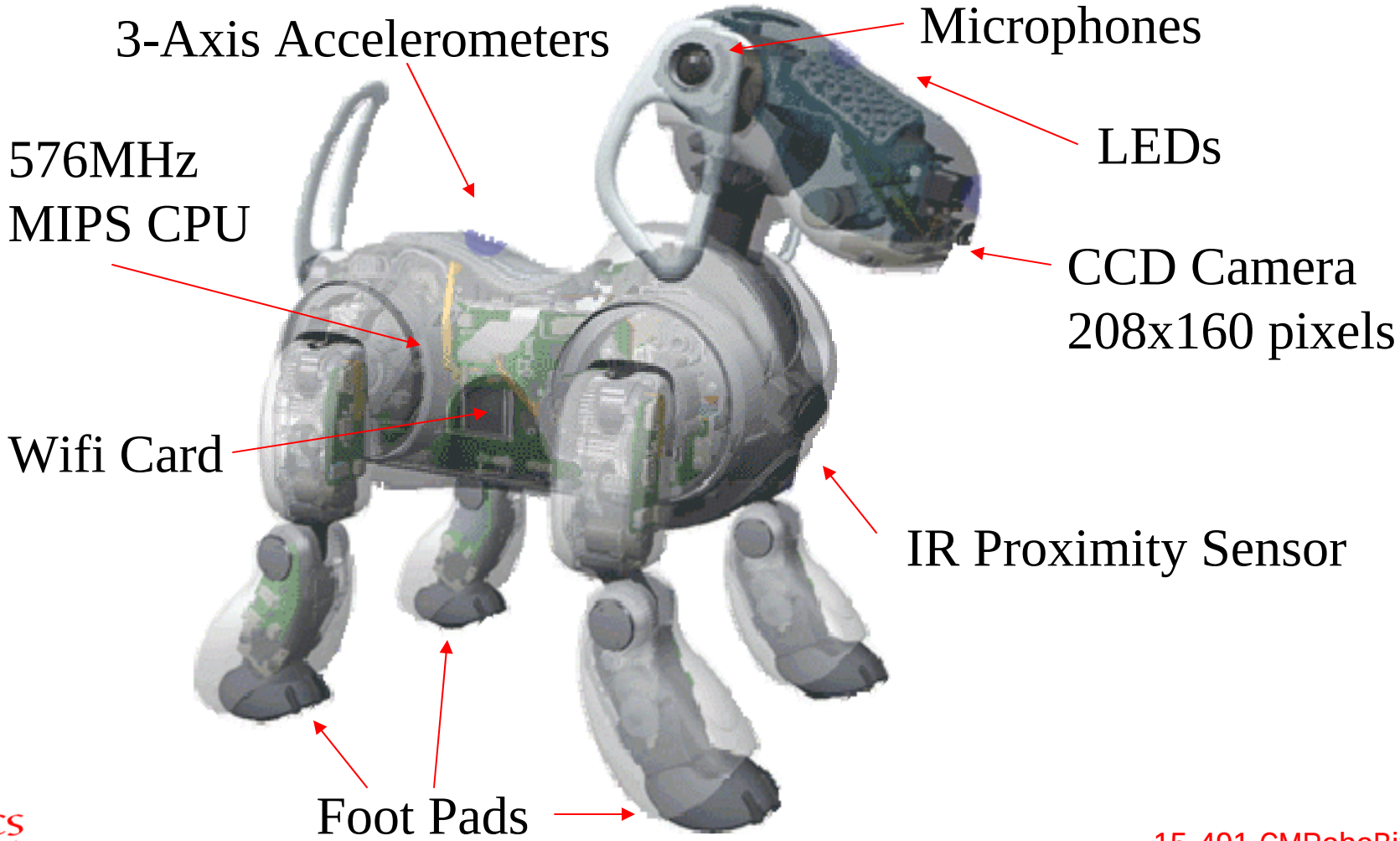
What is a *Robot*?

- Many *robots*…



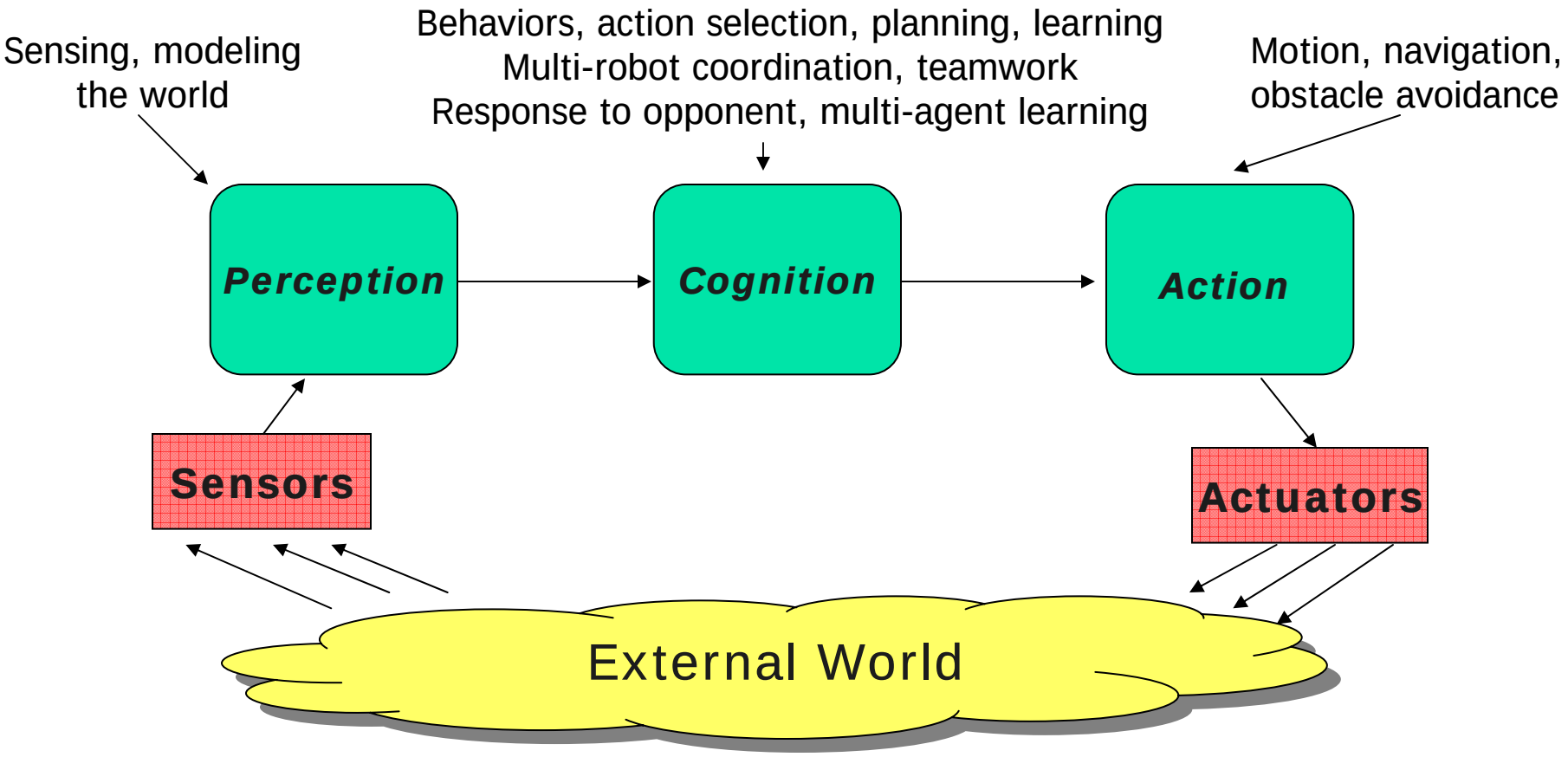

Roboceptionist

AIBO ERS-7


3-Axis Accelerometers
Microphones
576MHz
MIPS CPU
LEDs
CCD Camera
208x160 pixels
Wifi Card
IR Proximity Sensor
Foot Pads

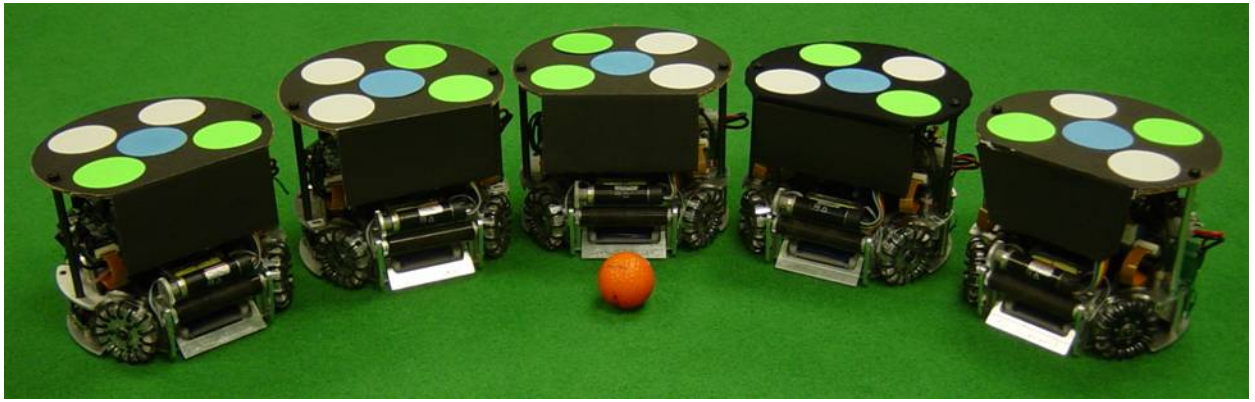
What is a Robot?

Intelligent Complete Robot



Course Motivations

- Robots are *integrated intelligence:*
  - Sensing & perception
  - Behavior & cognition
  - Learning from the real world
  - Motion & kinematics
  - Multi-robot cooperation & coordination

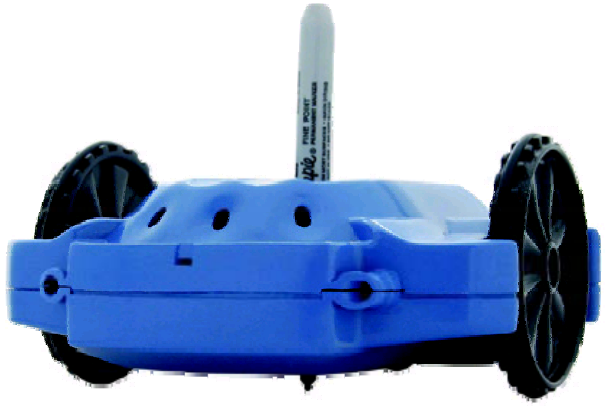


The CMRoboBits Course

- Making robots accessible to all
- How do you solve problems in “real-time”?
- Sensors are inherently noisy. How do you develop behaviors robust to errors?
- How do you coordinate the actions of multiple robots?

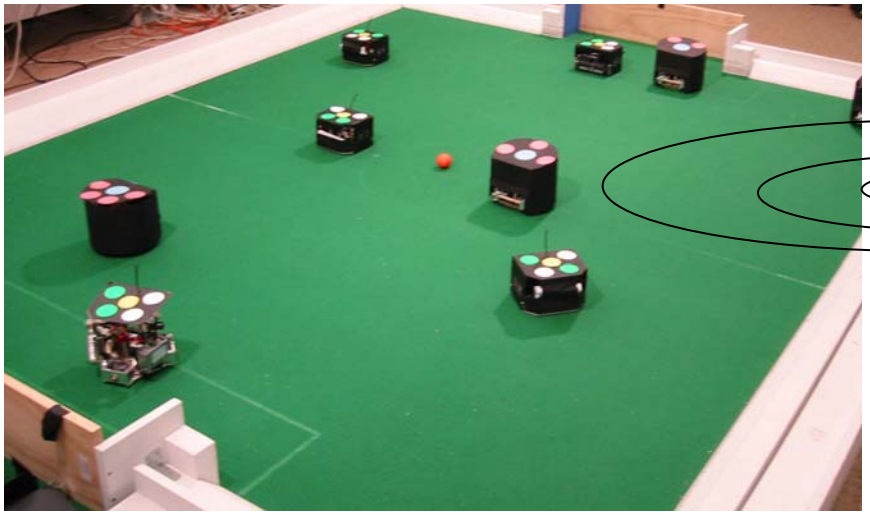
CMRoboBits Fall 2008

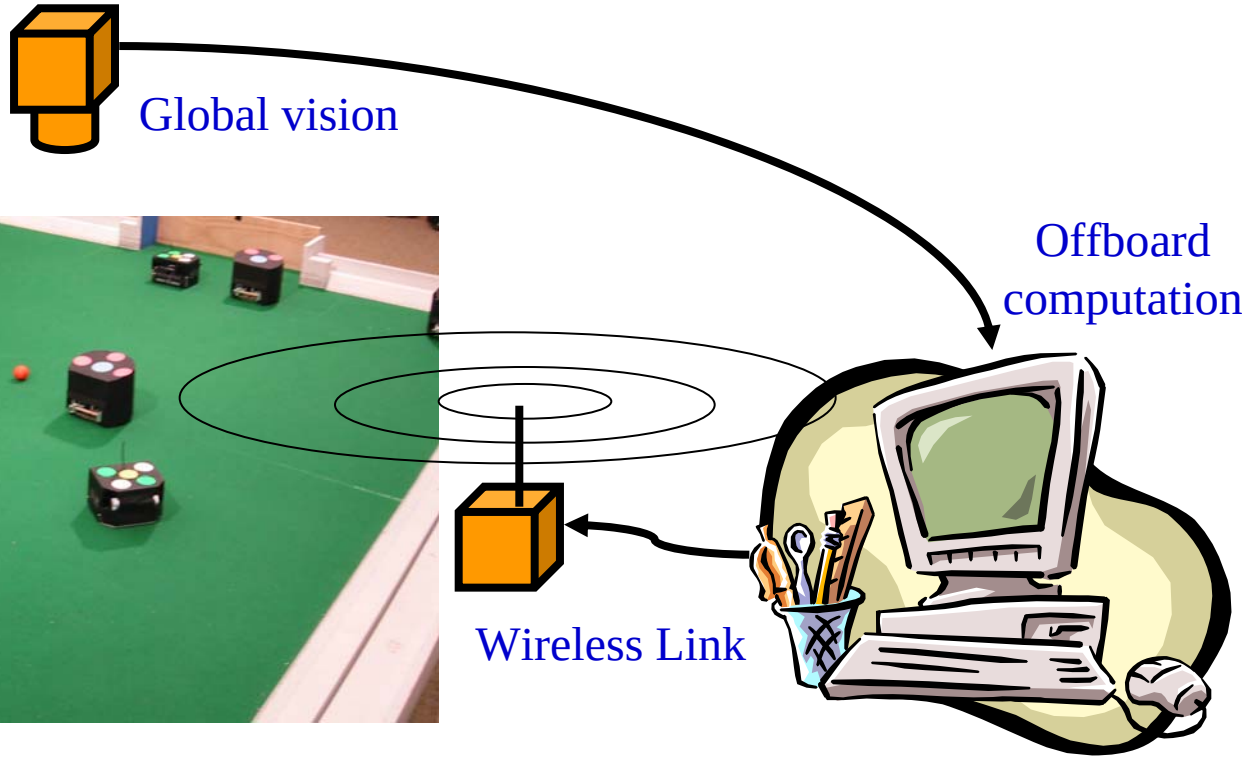
- Multiple robots
- iRobot Create, www.irobot.com
- Scribbler, www.scribblerrobot.com



Centralized Perception, Centralized Control

10 robots + golf ball
5 robots per team
Color markers for ID





Robot team is autonomous as a *whole*

Scribbler, Simplest Obstacle Avoidance

```
def main():
    while True:
        L,R = getIR()
        if L and R:
            move(0,0)
        elif L:
            move(0.6,-0.5)
        elif R:
            move(0.6,0.5)
        else:
            move(0.6,0)
```

CMRoboBits Main Topics

- Motion
- Sensing
- Behaviors
- Multi-robot coordination

Actions

- Effector – any device to effect on the environment
  - Legs, wheels, arms, fingers, speakers, etc
  - Physical work of some kind – walking, talking
- Actuator – a mechanism that enables the effector

Passive Actuation (e.g. Delft, MIT, Cornell)

Active Actuation

- Electric motors
  - Most common
- Hydraulics
  - Fluid pressure changes, the actuator moves
  - Powerful, precise, large, lots of care
- Pneumatics
  - Air pressure
- Photo-reactive materials
  - React to light, small work, micro-robotics
- Chemically, thermally, … reactive materials

Control

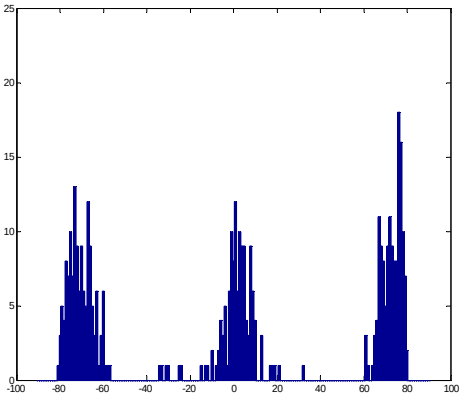
- Holonomic
  - Controllable DOF = TDOF
  - Helicopter (6 DOFs)
- Nonholonomic
  - CDOF < TDOF
  - Car 2/3, parallel parking
- Redundant
  - CDOF > TDOF
  - Human arm
  - Many solutions to moving from one place to other

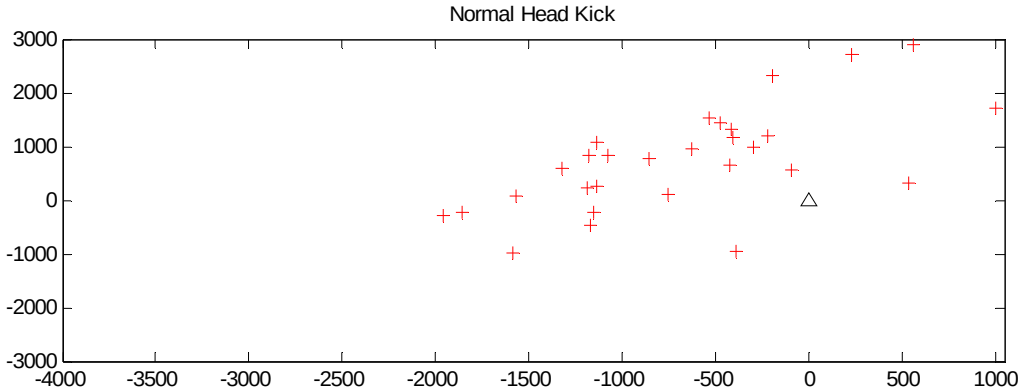
Uncertainty of Robot Actions

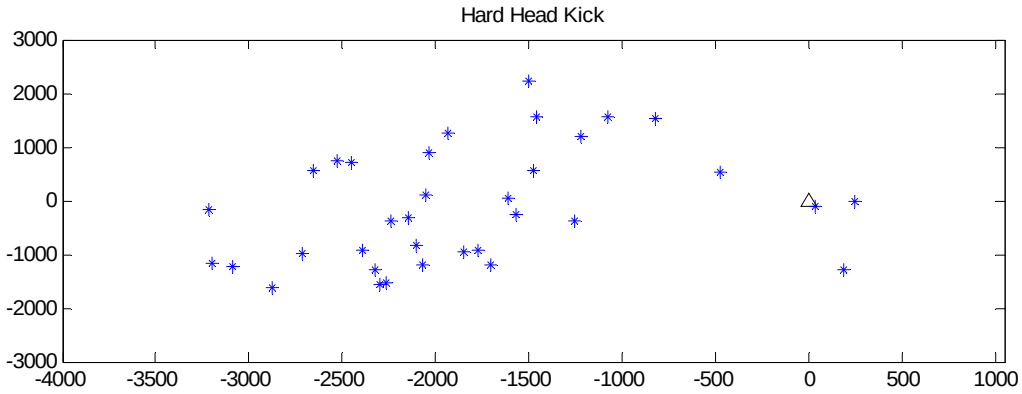
- Example: AIBO kicks as planned motions
  - frame-based with kinematic interpolation

Handling Uncertainty: Model-Based Kick Selection

- Modeling effects of different kicks
  - Angle analysis





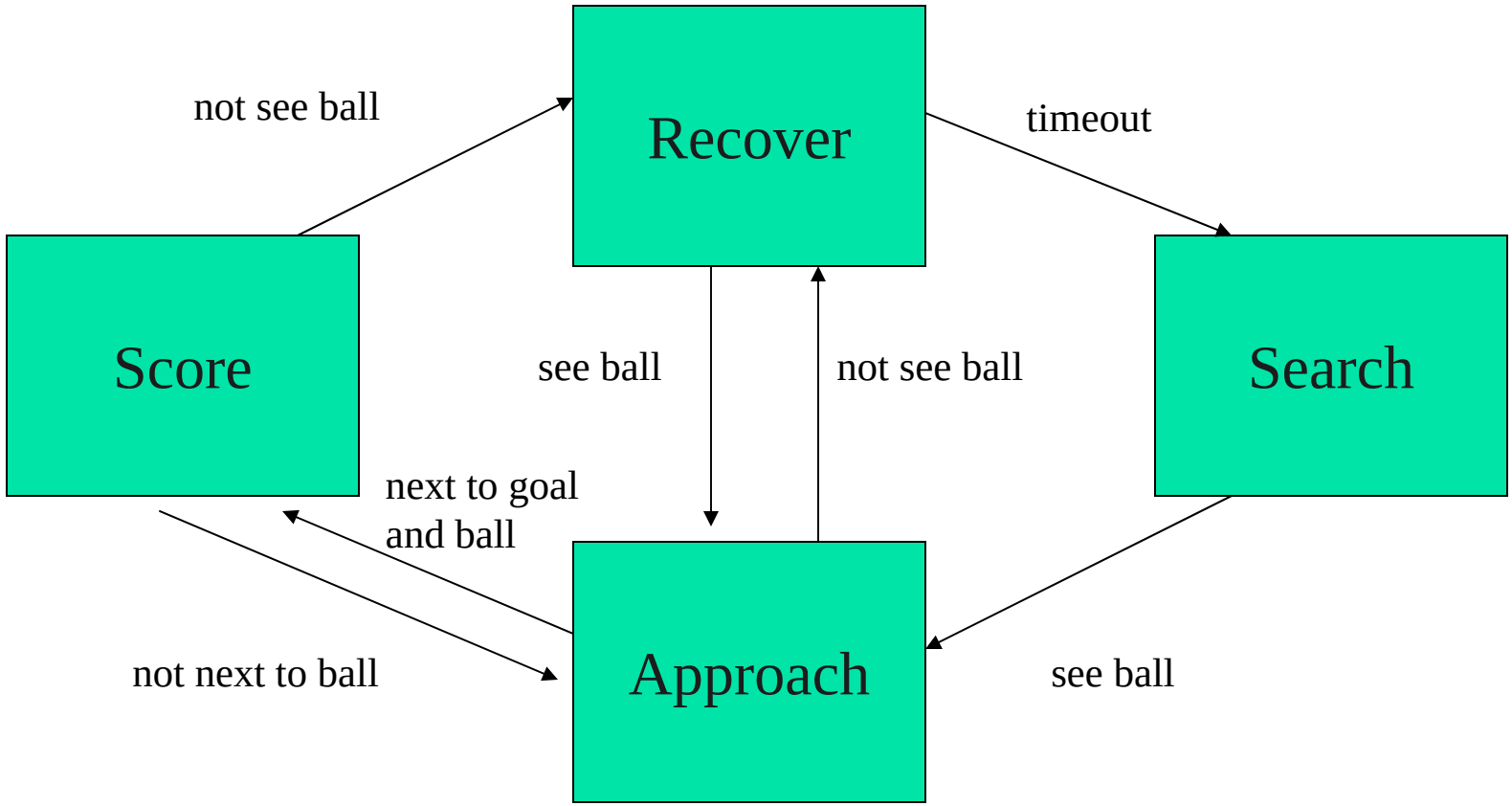


  - Strength analysis

Sensors

- Bump sensors
- Accelerometer
- Vision

Cognition: Behaviors



Conclusion

- Working within the perception, cognition, action loop
- Working with multiple robots
- Microsoft Robotics Studio – MSRS

- An exciting course.

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