Introduction to Robotics

Manipulation and Programming

Unit 4: Motion Control

MOBILE ROBOT PART 2 –BEHAVIORAL APPROACH

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Objectives

- Overview of Behavioral Approach.

- How behavioral approach is used?

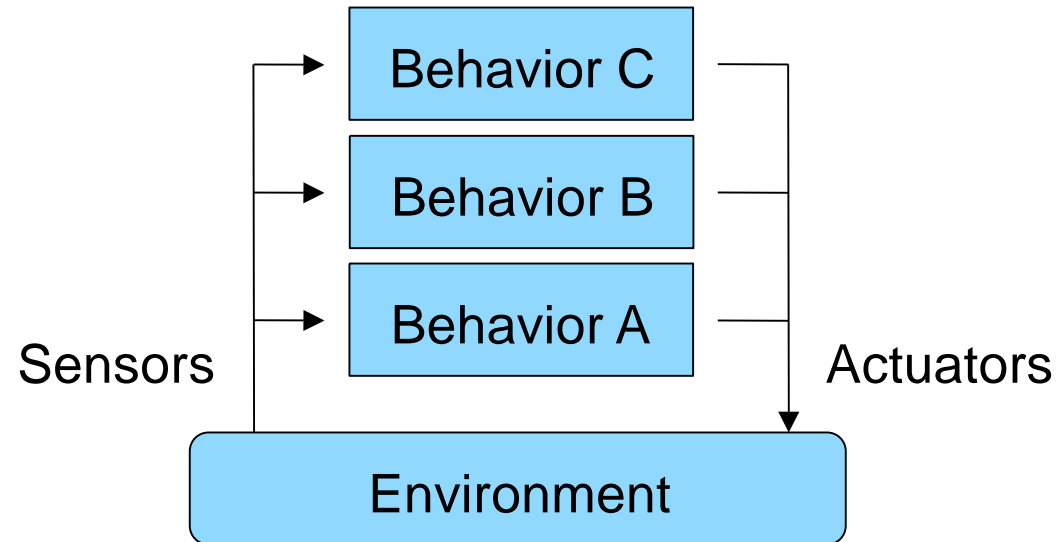# Overview of Behavioral Approach

SECTION 1

Action-Behavior-Method

- Behavior is an **action**. In Object-oriented term, it is a method.

- Behavioral approach is similar to event-driven approach.

- Taking the best candidate behavior.

Behavioral Approach

Behavior C

Behavior B

Behavior A

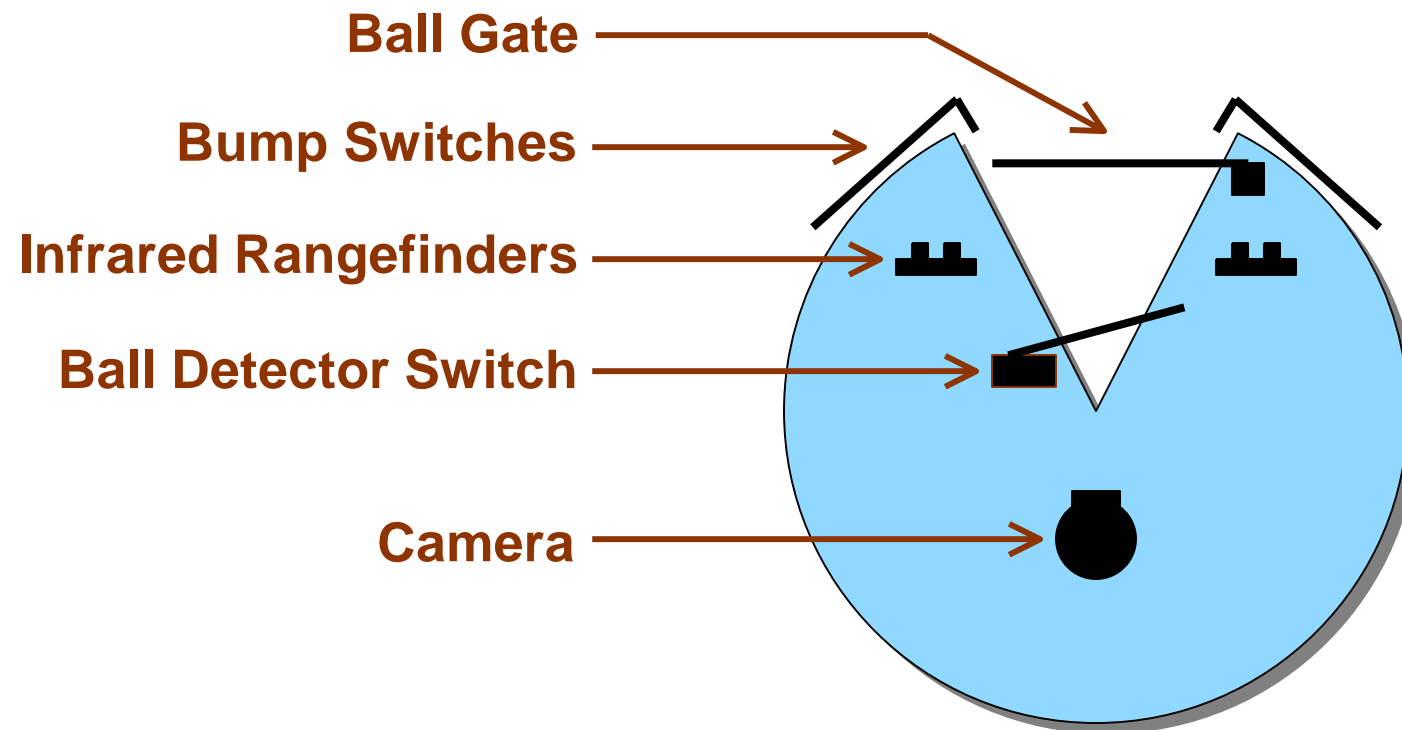Sensors

Actuators

Environment

- As in simple biological systems, behaviors directly couple sensors and actuators.
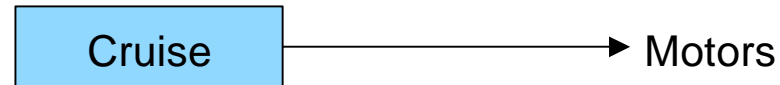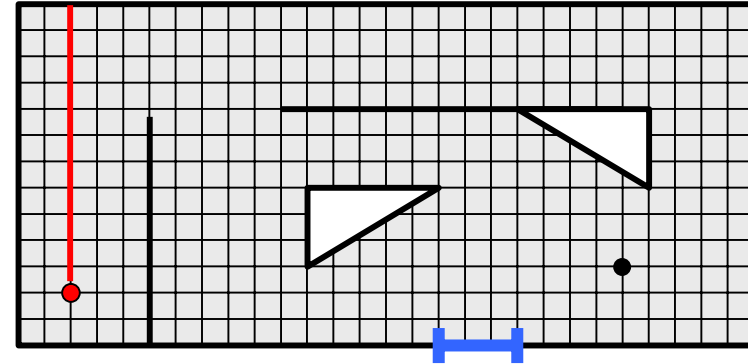- Higher level behaviors are layered on top of lower level behaviors

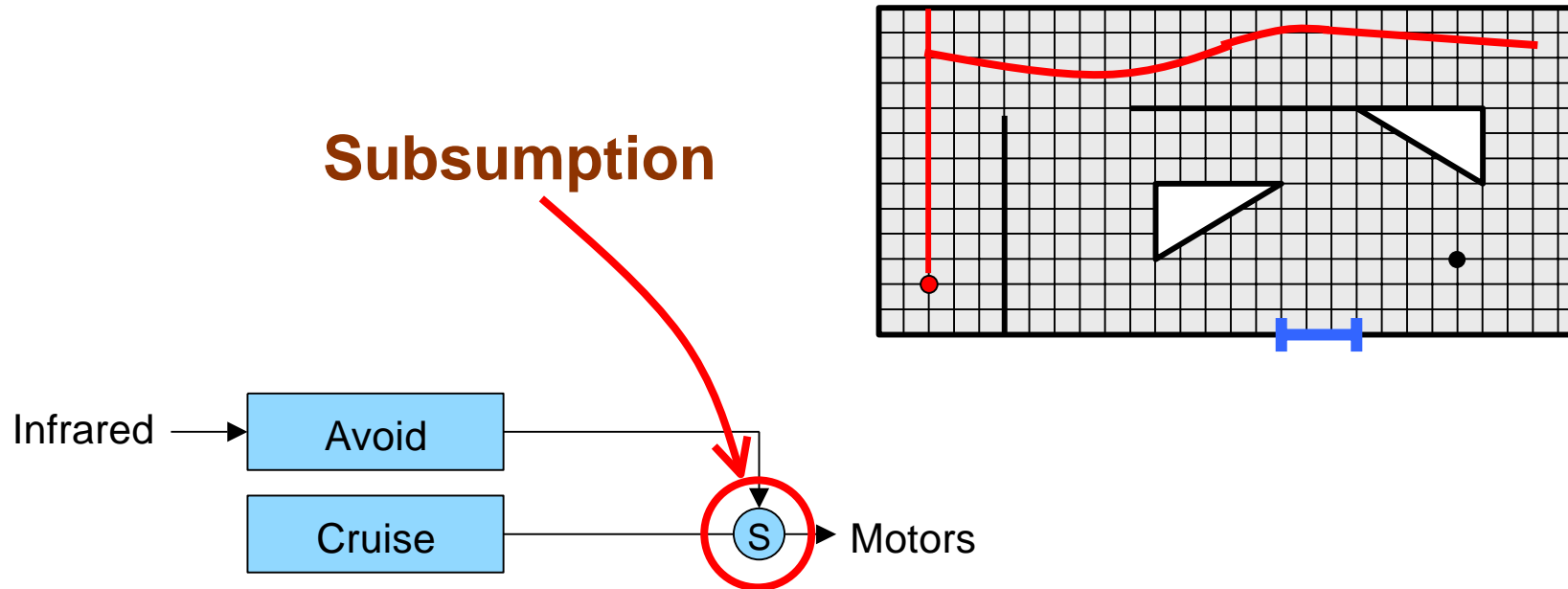# To illustrate the behavioral approach we will consider a simple mobile robot

Layering simple behaviors can create much more complex emergent behavior


```
Cruise  ────────────►  Motors
```

- Cruise behavior simply moves robot forward

Layering simple behaviors can create much more complex emergent behavior
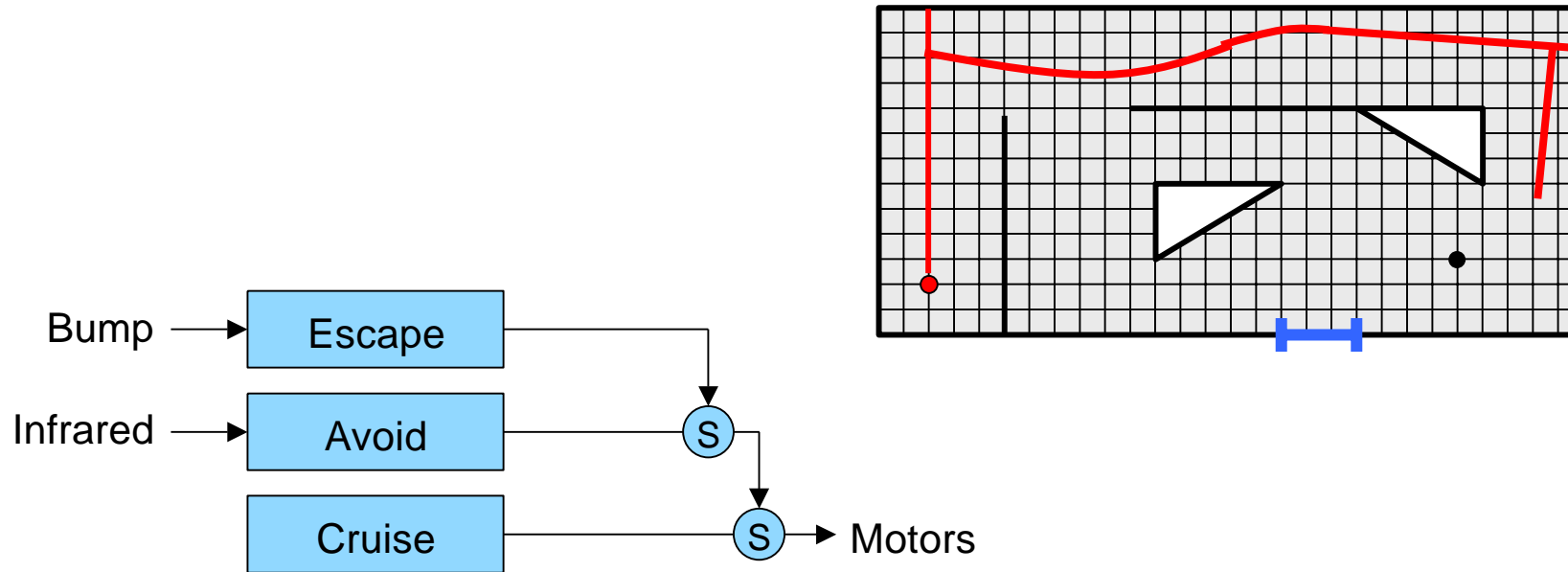
Subsumption

Infrared → Avoid

Cruise

S → Motors

- Left motor speed inversely proportional to left IR range
- Right motor speed inversely proportional to right IR range
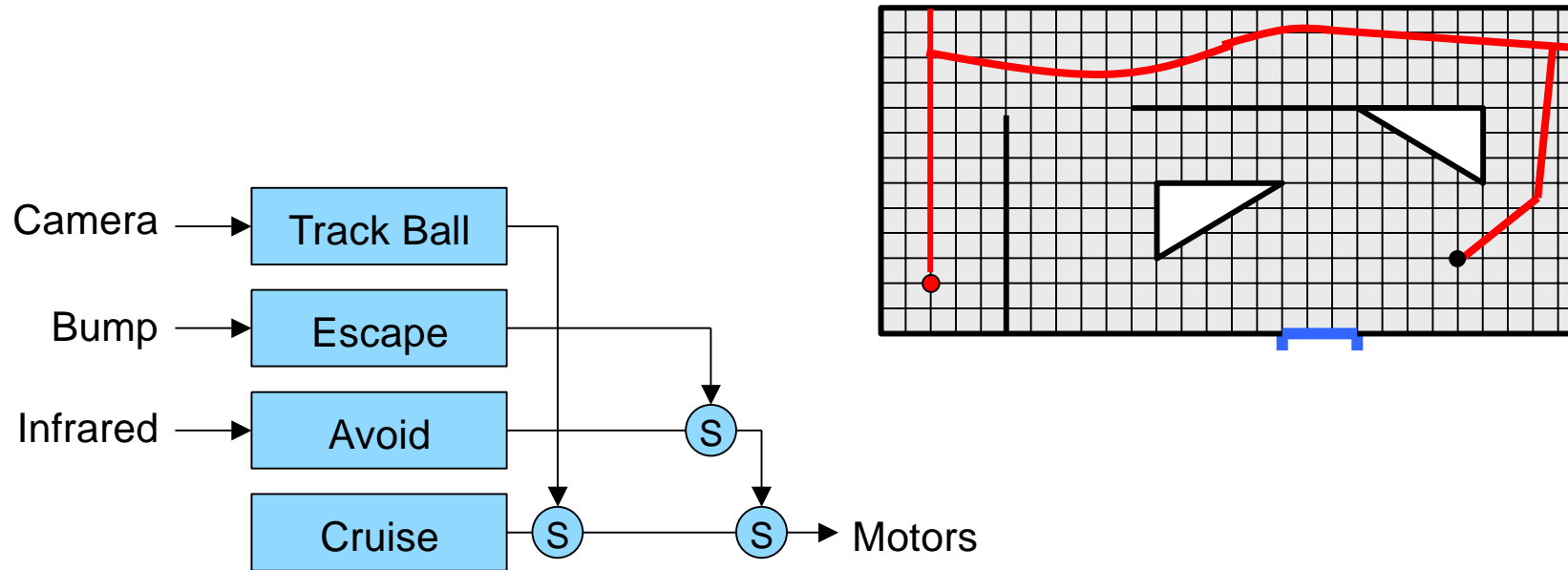- If both IR < threshold stop and turn right 120 degrees

Layering simple behaviors can create much more complex emergent behavior

- Escape behavior stops motors,
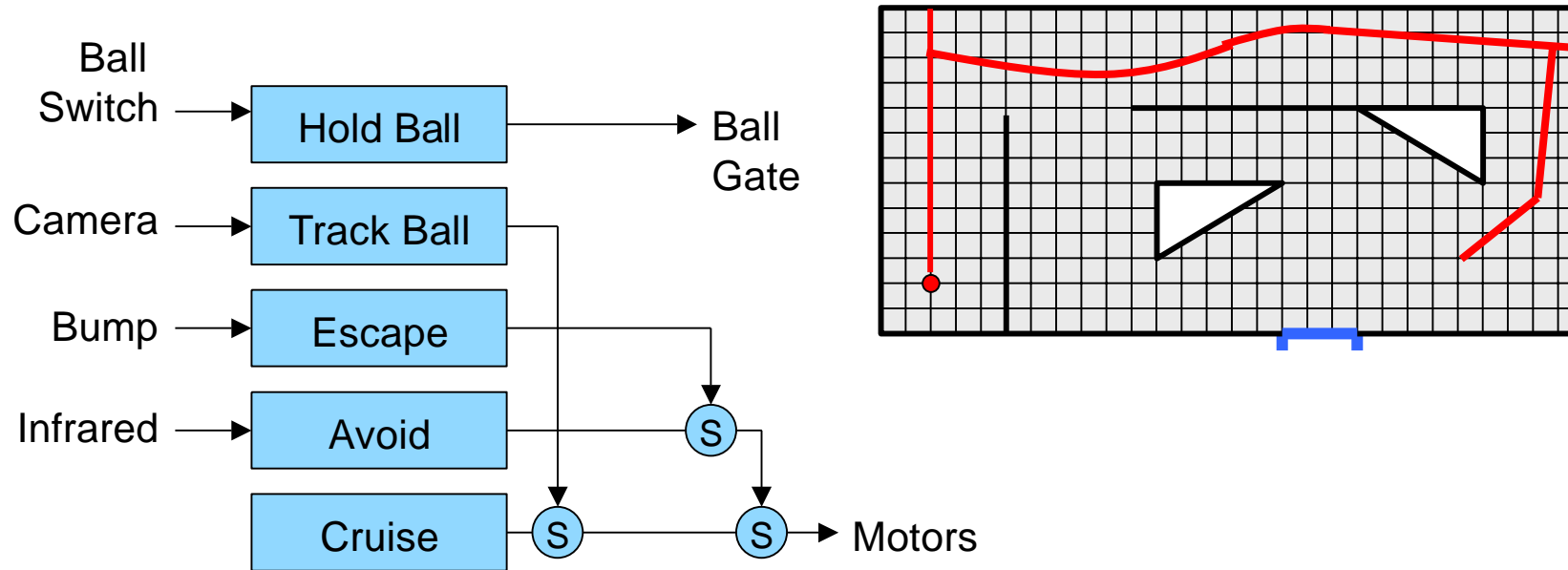- backs up a few inches, and turns right 90 degrees

Layering simple behaviors can create much more complex emergent behavior


```
Camera  →  [ Track Ball ]
Bump    →  [   Escape   ]
Infrared →  [   Avoid   ]  → (S)
           [   Cruise   ] → (S) → (S) → Motors
```

- The track ball behavior adjusts the
- motor differential to steer the robot towards the ball

# Layering simple behaviors can create much more complex emergent behavior

- Hold ball behavior simply closes ball gate
- when ball switch is depressed

Layering simple behaviors can create much more complex emergent behavior

- The track goal behavior opens the ball gate and adjusts the motor differential to steer the robot towards the goal
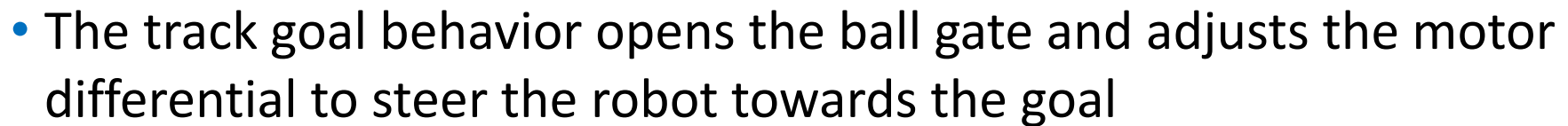
Layering simple behaviors can create much more complex emergent behavior
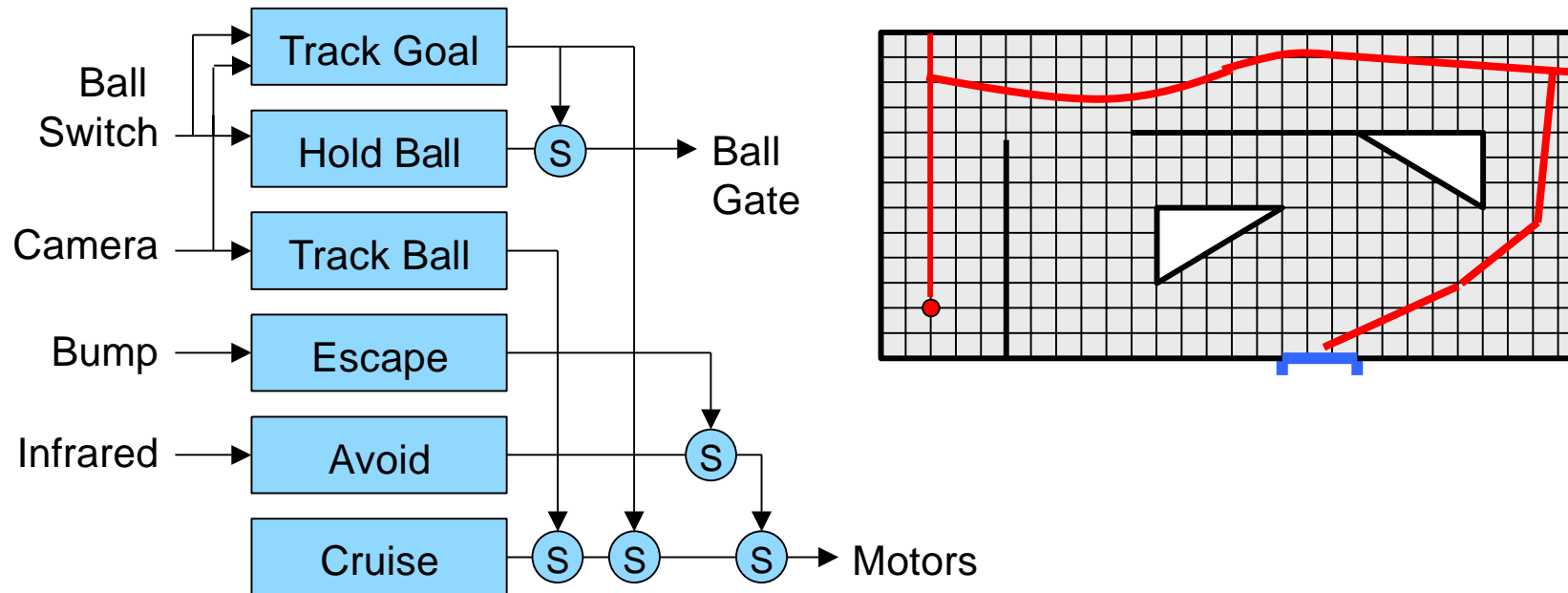
- All behaviors are always running in parallel and an arbiter is responsible for picking which behavior can access the actuators

Summary

# Advantages and disadvantages of the behavioral approach

Advantages
- Incremental development is very natural
- Modularity makes experimentation easier
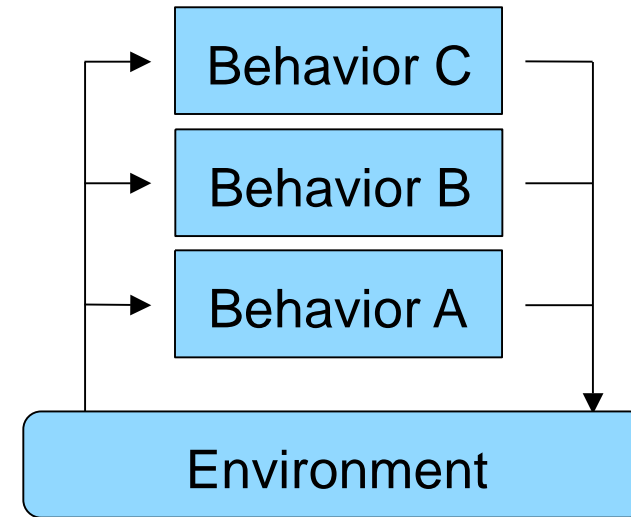- Cleanly handles dynamic environments

Disadvantages
- Difficult to judge what robot will actually do
- No performance or completeness guarantees
- Debugging can be very difficult

Model-plan-act fuses sensor data, while behavioral fuses behaviors
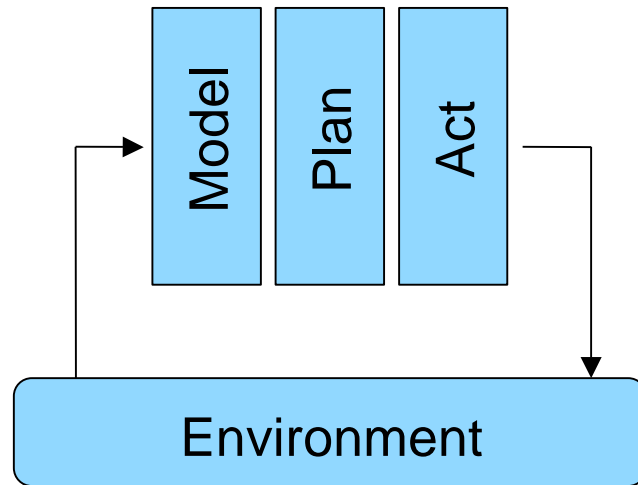
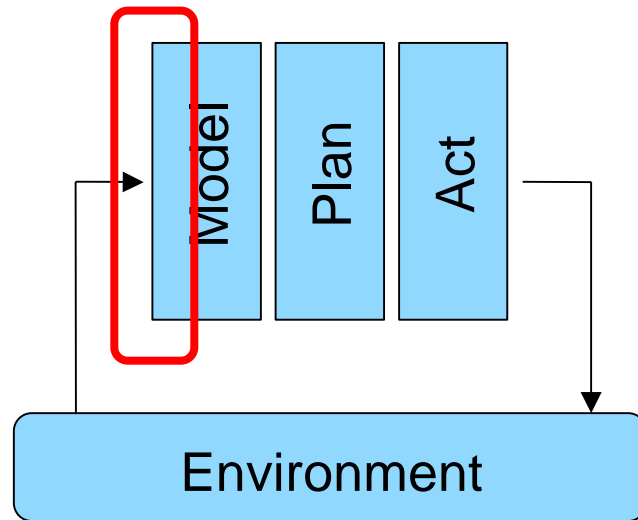**Model-Plan-Act**
(Fixed Plan of Behaviors)
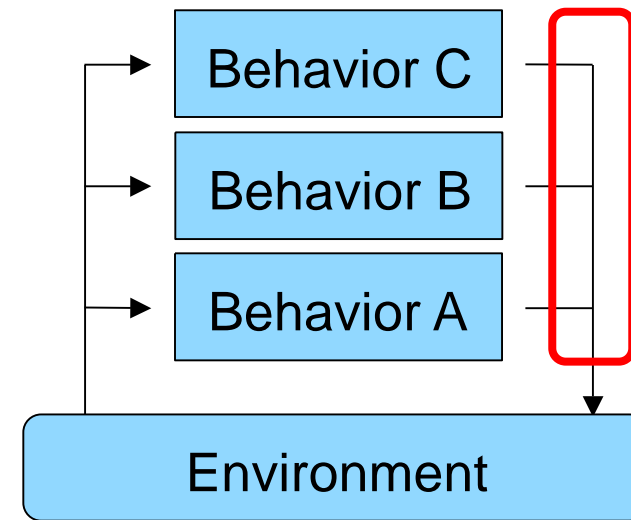
Behavioral
(Layered Behaviors)

Model-plan-act fuses sensor data, while behavioral fuses behaviors
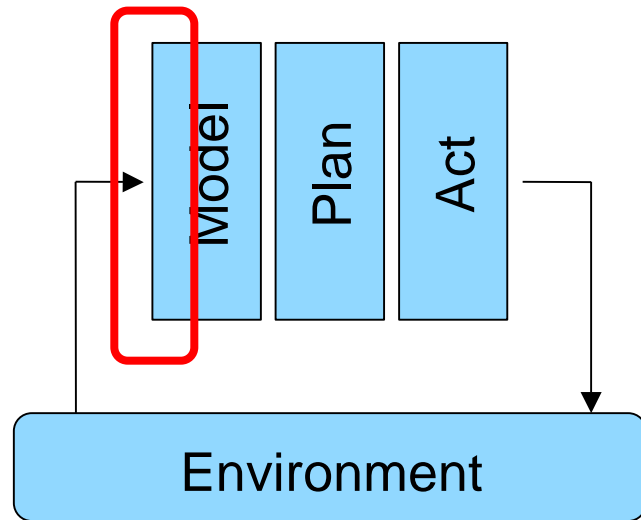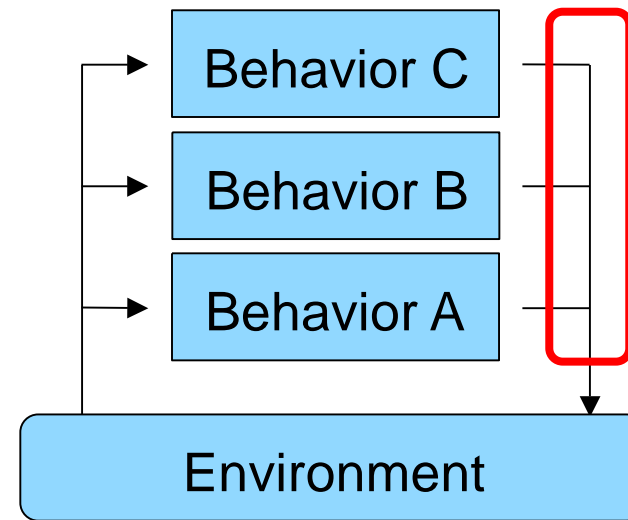

Model-Plan-Act
(Sensor Fusion)

Behavioral
(Behavior Fusion)

Model-plan-act fuses sensor data, while behavioral fuses behaviors

Model-Plan-Act
(Sensor Fusion)

Behavioral
(Behavior Fusion)