Lecture 2-2: The Reactive Paradigm

Reading: Chapter 4

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Objectives:

- Define the reactive paradigm in terms of the 3 primitives and sensing organization
- List the characteristics of a reactive robotic system
- Describe two common methods for combining behaviors in a reactive architecture
- Evaluate subsumption and potential fields architectures

There are two main reactive systems

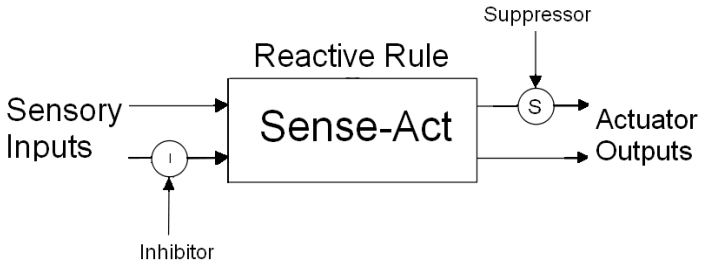
1. _____
2. _____

Subsumption Architecture uses layer of behaviors and controls relationships between then.

Potential fields uses concurrent behaviors and summation typically for navigation.

They are both equivalent in power and there may be a mixture of the two reactive systems.

Each layer of the subsumption architecture is represented by the following block diagram,



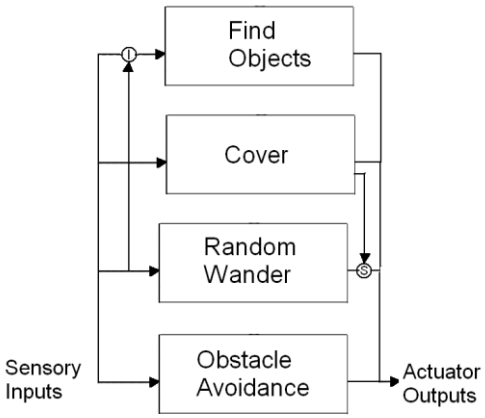
The sensory input may be _____ so that the rule does not compute a reaction and send an output to the effectors.

The actuator output may be _____ so that there is a sensory input but no output to the effectors.

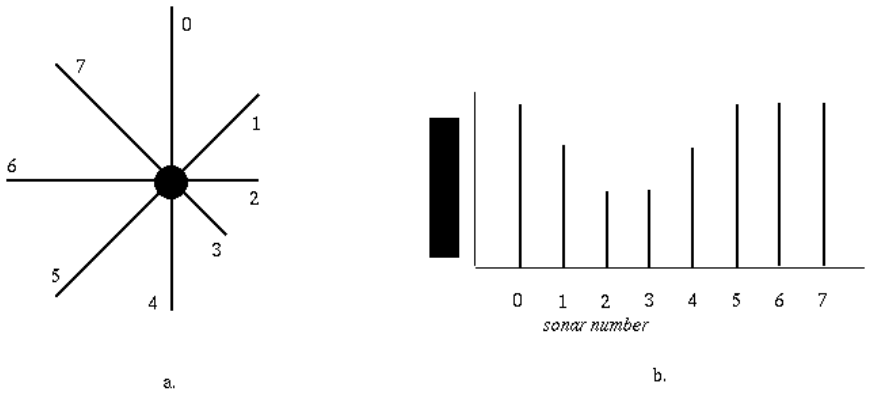
The architecture is bottom up with the simpler layers at 0 which can be used or subsumed by the higher levels.

In subsumption architecture the ***world is its own best model*** there is no internal representation and sensing is used to achieve tasks.

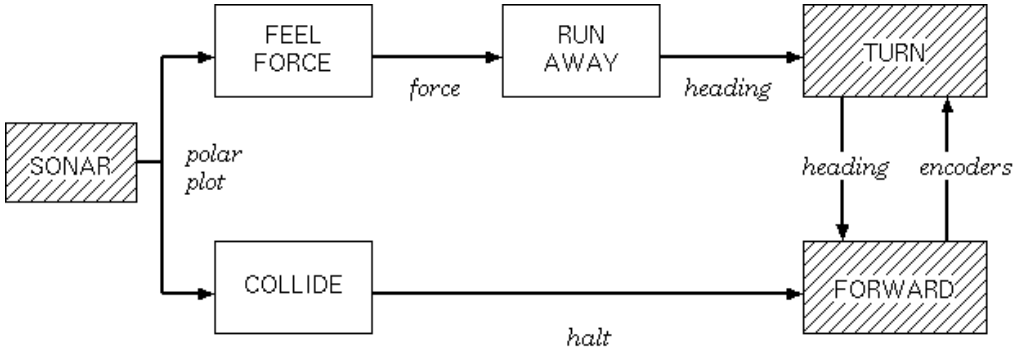
The following figure provides an example of a subsumption architecture for a robot to explore an environment by wandering, performing a cover algorithm, looking for objects while avoiding obstacles. Note that if the robot uses the cover algorithm then it **suppresses** the actuator commands to wander randomly. Also, if the robot wanders randomly **inhibits** the sensor input to look for objects.



One way to eliminate the need for representation is to use a ***perception polar plot*** to extract salient features from the environment. The following figure indicates that that there is a wall or obstacle on the right side of the robot.



This sonar polar plot can be used to implement run away, wander, and follow corridor reactive rules. For level 0, if the polar plot indicates that the robot hit an object then it should stop moving. The polar plot is also used to determine the strength of the force from the object to generate a turn angle to move the robot away and then move forward.



Level 1 is the next higher level and involves robot wander along with avoiding obstacles. In order to avoid obstacles there must be input from the Layer 0 run away reactive rules. Level 1 then suppresses the output from Run away in order to modify the robot's turn angle to continue to wander while avoiding obstacles. Lastly, level 2 uses input from the run away level to follow down the center of a hallway. It subsumes the wander input to the obstacle avoidance rule in order to move to the center. The follow corridor also receives input from the turn and forward in order to keep the robot in the middle of the hallway.

What are some of the limitations of the subsumption architecture?

- _____
- _____
- _____
- _____

In order to describe the potential fields reactive system it is necessary to define

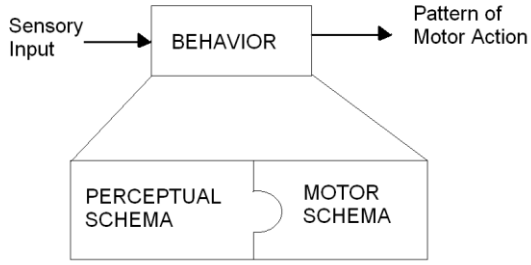
_____

_____ is used to express the knowledge of how to perceive and act and the computational process to accomplish this activity.

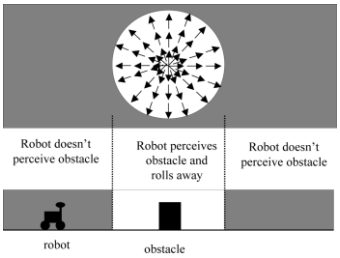
The ***motor schema*** represents the template for the robot's physical activity

The ***perceptual schema*** embodies the robot's sensing

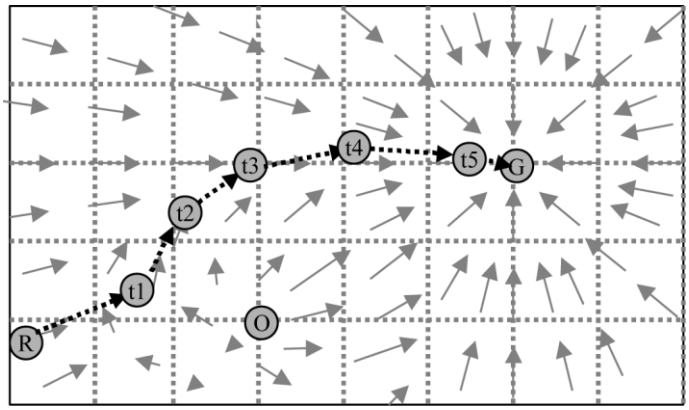
These two schemas work together to produce the sense-act pair for a robot's ***behavior*** which is a special case of a reactive rule.



The motor schema can be described by the ***potential fields methodology*** where the robot feels the vector force by summing the magnitude and direction of the sensor data.

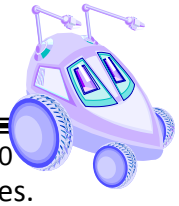


The potential field methodology is used to creating emergent behavior by summing the reactive rules. In the following figure the robot does not compute a path but uses local sensing to traverse a path from the start point to the goal point while avoiding the obstacle.



What are some of the advantages of the potential field methodology?

What are some of the disadvantages of the potential field methodology?



Draw the hierarchical and reactive control architectures in terms of the 3 robot primitives.

Compare and contrast the differences between the hierarchical and reactive control architectures.