Homework #3

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ECE 564/565: Fundamentals of Autonomous Robots

1 Describe the three levels of Computational Theory.

Computational Theory is used to understand the cognition of agents with the goal of understanding and possibly implementing equivalent functionality.

1.1 Level 1: Existence proof of what can/should be done.

At the lowest level of computational theory, level 1. At this level the roboticist is searching for existing agents that share a commonality of purpose or functionality to use as a proof of concept.

1.2 Level 2: Decomposition of "what" into inputs, outputs, and transformations.

At this level, the agent is formulated as a flow chart of "black box" transformations. It may not be a complete theoretical equivalent, but it can be used as an idea of how to duplicate desired functionality. Agents at this level can exhibit common processes.

1.3 Level 3: How to implement the process.

At this level, the roboticist is focused on implementing the "black box" transformations described in Level 2. It is important to note that although the functionality might have been referenced from existing agents found in Level 1, agents may have no commonality in their implementation.

2 Explain in one or two sentences each of the following terms:

2.1 Reflexes

Reflexes are responses that last only as long as the stimulus occurs. These responses are proportional to the intensity of the stimulus.

2.2 Taxes

Taxes are responses where the agent moves or alters its orientation. For instance, light tracking or chemical trails are example of a taxes.

2.3 Fixed-action patterns

A fixed-action pattern is a response that continues longer than the duration of its stimulus.

2.4 SCHEMA

A schema is made up of both data and methods. Data includes knowledge and models, information needed to know how to act and perceive while the methods are the computational processes by which the agent accomplishes its goals.

3 CONSIDER A MOSQUITO HUNTING FOR A WARM-BLOODED MAMMAL AND A GOOD PLACE TO BITE THEM. REPRESENT THIS WITH SCHEMA THEORY (PERCEPTUAL AND MOTOR SCHEMA).

Since the mosquito is hunting for warm-blooded animals, thermal differences are useful for finding a good place to bite.

Perceptual Schema: Determine the warmest nearby area.

Motor Schema: Move in the direction of the warmest nearby area.

4 HOW DOES THE REACTIVE PARADIGM HANDLE THE FRAME PROBLEM AND THE OPEN WORLD ASSUMPTION?

The frame problem refers to the large computational cost of implementing every detail about an environment. A robot operating in a completely known environment is operating under the closed world assumption; while, a robot operating in a partially known or unknown environment is operating under the open world assumption. The reactive paradigm does not require full knowledge of the environment to perform, only the data from its reactive percepts. It has no issue with the computational load described in the frame problem and operates under the open world assumption.

5 CONSIDER THE EXAMPLE WE DID IN THE CLASS AS SHOWN IN THE BOOK DIAGRAM BELOW:

5.1 A.)

5.2 B.)

5.3 C.)

6 ASSUME THAT YOU ARE DESIGNING A CONTROLLER FOR A
ROBOTIC ARM SYSTEM. YOU DO NOT CARE ABOUT THE RISE-
TIME AND SETTLING-TIME OF THE SYSTEM (IT COULD BE LARGE OR
SMALL) BUT YOU DO CARE ABOUT THE OVER-SHOOT AND
STEADY-STATE ERROR OF THE SYSTEM. YOU WANT TO HAVE
MINIMUM OVERSHOOT AND **MINIMUM (NOT NECESSARILY ZERO)
STEADY-STATE ERROR.** WHAT KIND OF CONTROLLER WOULD
YOU USE IN TERMS OF P, I, D? CHOOSE THE SIMPLE
CONTROLLER POSSIBLE. EXPLAIN CLEARLY.

I would use a PD Controller. Although the P (Proportional) Control would increase the overshoot, it would decrease the steady-state error to near zero. The D (Derivative) Controller is necessary for reducing the overshoot and has no effect on the steady-state error. An I (Integral) controller would not be used because it eliminates the steady-state error to zero and further increases overshoot.