

CSE 4392 / CSE 5392 - *Smart Home Technologies*

Homework 4- Spring 2006

Due Date: April 27 2006, 3:30 pm

Components

- CLIPS rule-based expert system shell
- xclips graphical interface

Problems marked with a * are required only for students in the graduate section (CSE 5392). They will be graded for extra credit for students of CSE 4392.

The goal of this assignment is to automate decisions in a smart home environment with a single inhabitant. For this purpose you are going to build a rule based decision system that automates lights and the AC/heating system, and that operates a security guard robot to check for intruders in the home. To implement the decision maker you will be using CLIPS, an expert system shell that permits you to build a rule-based decision system.

Smart Home Simulation

For this assignment, the Smart Home simulator is implemented directly in CLIPS. There are two CLIPS files on the web site, one containing the basic simulation of the home and the underlying facts, and one containing a set of example rules to illustrate how to interact with the home. You should not have to look at the simulation file for this assignment. The facts representing the state of the home and the implemented scenario are as follows:

- Each room is indicated by an integer between 1 and 6, each of which maps to a room in the Smart Home simulation as follows: 1 = Bedroom, 2 = Bathroom, 3 = Hallway, 4 = Den, 5 = Livingroom, 6 = Kitchen
- The location of the inhabitant in the home is determined using a set of occupancy sensors and represented as (*location room# t/f*) for each room, where (*location 1 t*), for example, indicates that there is someone in room 1
- The status of the lights is indicated by (*lights room# on/off*) where (*lights 1 on*), for example, indicates that the lights in room 1 are turned on.
- The status of the AC/Heating system are is represented by (*ac room# cool/heat/off*). Here each room is regulated individually and (*ac 1 heat*) implies that the control for room 1 is turned to heating.
- The temperature in each room is represented by (*temperature room# temp*). For example, (*temperature 1 70*) indicates that the temperature in room 1 is currently 70 degrees.
- The time is represented as (*time Hr# Min#*) with (*time 7 45*) representing 7:45 am. The time is measured in military time (i.e. 2:00 pm is (*time 14 0*)).
- There are a few additional facts in the environment. Of particular interest is here (*power #WHr*) which represents the electricity used since the beginning of the scenario.

- The scenario implemented is a single inhabitant who prepares to go to work in the morning (and goes there at relatively irregular times) and comes back at around 5:00 pm in the afternoon. After she leaves there appears from time to time an intruder in the home.

Part A: Automating the AC and Heating System

In this part you are to design a set of rules that automate the AC and heating system to keep the temperature in each room of the home in a comfortable range while conserving energy. For this purpose the temperature should be adjusted based on the occupancy of the rooms in the home.

1. Make yourself familiar with the operation of CLIPS, the expert system shell.
2. Implement a set of rules that control the heating and airconditioning system such that the temperature stays between 68 and 75 degrees if the inhabitant is in the room, between 66 and 77 degrees in the other rooms while the inhabitant is in the home, and between 64 and 78 degrees if the inhabitant is at work (i.e. has already left). Your system should ideally not adjust the temperature for the intruder.

Turn in: (1) your rule set and (2) a short description of your rules.

Part B: Predictive Light Control

In this part you are to design an additional set of rules that attempts to automate the lights such that the inhabitant does not have to turn them on. For this purpose you have to extract some of the behavioral patterns of the inhabitant and translate them into rules such that your system can turn on lights before the inhabitant chooses to do so. In this assignment you can extract the patterns of inhabitant behavior manually by monitoring the movement of the inhabitant for a few runs.

1. Extract a set of predictions of user locations. NOTE: you do not have to predict all the movements of the inhabitant but you should be able to establish at least 3 short patterns of behavior.
2. Implement a set of rules that use the prediction patterns to anticipate when the inhabitant will enter a room and turns on the light for her. Your system should also turn lights back off if the inhabitant will no longer enter the room.

Turn in: (1) the set of predictive patterns, (2) your rule set, and (3) a short description of the rules including an evaluation of their effectiveness (i.e. a statistics of how many times your rules correctly turned on lights before the user entered a room and how frequently the rules turned on lights and the inhabitant did not enter the room). You should establish effectiveness over at least 3 runs.

Part C: Finding an Intruder with a Security Robot

In this part you are to design an additional set of rules that attempts to detect when an intruder entered the house (i.e. When someone entered the house after the inhabitant left but before she returns at around 5:00 pm). To verify the intruder the decision system should send the security robot into the specific room.

1. Implement rules that detect the intruder in the house and produce an alarm.

- 2.* Implement a set of rules that move the security robot to the specified room. You can move the robot from one room to the next but not jump through rooms. If there is no intruder in the house the robot should stay in the hallway.

Turn in: (1) your set of rules and (2) a short description of the rules.