

CS 2502/486 2008 Assignment 4

Due: December 5+

In this assignment, we consider a robot that shops at a supermarket for items on a shopping list (bread, oranges, beluga caviar, *etc.*). Initially, the robot is at home; then it drives to the supermarket, where there is a shopping cart, and proceeds to shop. As it selects items from the list, it places them in its shopping cart, then it pushes the cart to the appropriate area of the supermarket to pick up the next item. Finally, it goes to the check-out counter to pay, transfers the groceries to its car, and drives home.

We can describe this world in the situation calculus using the following fluents: $\text{Holding}(x, s)$ (the robot is holding object x), $\text{In}(x, y, s)$ (object x is inside container y), and $\text{At}(x, y, s)$ (object x is at location y). We also have the following actions: $\text{pickup}(x)$ (the robot picks up object x), $\text{putin}(x, y)$ (the robot puts object x into container y), $\text{drive}(x, y)$ (the robot causes container x to go to location y), and checkout (the robot pays for the items in its cart). We also have non-fluent predicates for the various types of objects (grocery items, locations, containers), and constants for the named objects of interest, the robot, bread and other groceries, a car, a grocery cart, and a variety of locations. Finally, we use $\text{ShoppingList}(x)$ to say that x is one of the grocery items the robot needs to buy. Note that we are imagining that there are locations within other locations, for example, a bakery within a supermarket within a city. We use the predicate $\text{SubLocation}(x, y)$ to say that location x is within location y . So objects will not be at unique locations in general.

1. Write precondition axioms for the four actions. You may refer to specific objects by name to say, for example, that it is only possible to drive the car to certain specific locations.
2. Write effect axioms for the pickup, putin, and drive actions (the checkout action here has no effect). Note that driving a container from one location to another also moves everything in that container.
3. Show how a successor state axiom for In would be derived from these effect axioms. Explain why the successor state axiom is not logically entailed by the effect axioms.
4. Show how a frame axiom is entailed by this successor state axiom.
5. Write the successor state axioms for the other two fluents.
6. Sketch informally a Golog procedure groceryShop that carries out the actions of the robot.
7. Write a formula α with one free variable s that states the goal condition to be achieved by the procedure groceryShop . What sentence using Do , groceryShop and α should be entailed by the KB?
8. Suppose we wanted to achieve the goal condition α without using a procedure or Golog. Explain how you could use Resolution to automatically solve the problem for any initial state. How would you generate the clauses, and assuming the process stops, how would you extract the necessary actions? (Do not attempt to write down a derivation!)
9. Suppose we were interested in formalizing this world using a STRIPS representation. Write the add list and delete list for the pickup and putin operators.
10. Consider the database corresponding to the a state of the world where the robot is located at the bakery in the supermarket and not holding anything. For each possible binding of the arguments of the pickup operator, state what the database progressed through that instance of the operator would be.
11. Consider a goal state which is to have bread and oranges in the cart. Describe the bindings of the two operators above for which that instance of the operator can be the final action of a plan, and in those cases, what the goal regressed through the instance of the operator would be.