12.2 Figure 12.1 shows the top levels of a hierarchy for everything. Extend it to include as many real categories as possible. A good way to do this is to cover all the things in your everyday life. This includes objects and events. Start with waking up, and proceed in an orderly fashion noting everything that you see, much, do, and think about. For example, a random sampling produces music, news, milk, walking driving, gas, Soda Hall, carpet, talking, Professor Fateman, chicken curry, tongue, $7, sun, the daily newspaper, and so on.

You should produce both a single hierarchy chart (on a large sheet of paper) and a listing of objects and categories with the relations satisfied by members of each category. Every object should be in a category, and every category should be in the hierarchy.

12.3 Develop a representational system for reasoning about windows in a window-based computer interface. In particular, your representation should be able to describe:

- The state of a window: minimized, displayed, or nonexistent.
- Which window (if any) is the active window.
- The position of every window at a given time.
- The order (front to back) of overlapping windows.
- The actions of creating, destroying, resizing, and moving windows; changing the state of a window; and bringing a window to the front. Treat these actions as atomic; that is, do not deal with the issue of relating them to mouse actions. Give axioms describing the effects of actions on fluents. You may use either event or situation calculus.

Assume an ontology containing situations, actions, integers (for x and y coordinates) and windows. Define a language over this ontology; that is, a list of constants, function symbols, and predicates with an English description of each. If you need to add more categories to the ontology (e.g., pixels), you may do so, but be sure to specify these in your write-up. You may (and should) use symbols defined in the text, but be sure to list these explicitly.

12.4 State the following in the language you developed for the previous exercise:

a. In situation So, window W1 is behind W2 but sticks out on the left and right. Do not state exact coordinates for these; describe the general situation.

b. If a window is displayed, then its top edge is higher than its bottom edge.

c. After you create a window w, it is displayed.

d. A window can be minimized if it is displayed.

12.5 (Adapted from an example by Doug Lenat.) Your mission is to capture, in logical form, enough knowledge to answer a series of questions about the following simple scenario:

Yesterday John went to the North Berkeley Safeway supermarket and bought two pounds of tomatoes and a pound of ground beef.

Start by trying to represent the content of the sentence as a series of assertions. You should write sentences that have straightforward logical structure (e.g., statements that objects have certain properties, that objects are related in certain ways, that all objects satisfying one property satisfy another). The following might help you get started:
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• Which classes, objects, and relations would you need? What are their parents, siblings and so on? (You will need events and temporal ordering, among other things.)
• Where would they fit in a more general hierarchy?
• What are the constraints and interrelationships among them?
• How detailed must you be about each of the various concepts?

To answer the questions below, your knowledge base must include background knowledge. You'll have to deal with what kind of things are at a supermarket, what is involved with purchasing the things one selects, what the purchases will be used for, and so on. Try to make your representation as general as possible. To give a trivial example: don't say "People buy food from Safeway," because that won't help you with those who shop at another supermarket. Also, don't turn the questions into answers; for example, question (c) asks "Did John buy any meat?"—not "Did John buy a pound of ground beef?"

Sketch the chains of reasoning that would answer the questions. If possible, use a logical reasoning system to demonstrate the sufficiency of your knowledge base. Many of the things you write might be only approximately correct in reality, but don't worry too much; the idea is to extract the common sense that lets you answer these questions at all. A truly complete answer to this question is extremely difficult, probably beyond the state of the art of current knowledge representation. But you should be able to put together a consistent set of axioms for the limited questions posed here_

a. Is John a child or an adult? [Adult]
b. Does John now have at least two tomatoes? [Yes]
c. Did John buy any meat? [Yes]
d. If Mary was buying tomatoes at the same time as John, did he see her? [Yes]
e. Are the tomatoes made in the supermarket? [No]
f. What is John going to do with the tomatoes? [Eat them]
g. Does Safeway sell deodorant? [Yes]
h. Did John bring some money or a credit card to the supermarket? [Yes]
i. Does John have less money after going to the supermarket? [Yes]

12.6  Make the necessary additions or changes to your knowledge base from the previous exercise so that the questions that follow can be answered. Include in your report a discussion of your changes, explaining why they were needed, whether they were minor or major, and what kinds of questions would necessitate further changes.

a. Are there other people in Safeway while John is there? [Yes—staff?]
b. Is John a vegetarian? [No]
c. Who owns the deodorant in Safeway? [Safeway Corporation]
d. Did John have an ounce of ground beef? [Yes]
e. Does the Shell station next door have any gas? [Yes]
f. Do the tomatoes fit in John's car trunk? [Yes]