New Mexico State University

CS 475, Artificial Intelligence I, Fall 1997

Assignment 4

Implementating a Question-Answering System in SNePS

Due Tuesday, November 11

In this assignment, you will design a SNePS representation to support a gardening question-answering system. You will demonstrate your system by showing that it can incrememtally add information to its knowledge base and then give appropriate answers to questions.

1 Issue: Individuals Versus Classes

We will distinguish between individual objects and types of objects, and between specific events and types of events. We want to disinguish between, for example, the items in the following table.

Julie watered the lawn deeply on Monday
vs.
People can use a hose to water lawns
People can use a sprinkler to water lawns
The grass at my house is Bermuda grass
vs.
Grass is green
Bermuda grass is dought tolerant
Bermuda grass is a type of grass
People use high-nitrogen fertilizer on grass
People use high-phosphorous fertilizer on roses

1.1 Objects

Let's use the following predicates for objects.

member(X,Y) means that X is an actual object that is a member of the class Y (In SNePS, the two arcs are often called "member" and "class")

subclass(X,Y) means that class X is a subclass of class Y (e.g., subclass(bermudaGrass, grass); In SNePS, the two arcs are often called "subclass" and "superclass").

partof(X,Y) means that X is a part of Y. *You can begin by using this both for two actual objects and for two object types, but you may find you need two different predicates.* When used for two object **types**, it means that, typically, objects of type Y have something of type X as a part.

hasprop(X,Y) means that object X has property Y. As for **partof**, you can begin by using this both for objects and for object types, but you may find you need two different predicates. When used for an object type, it means that objects of that type typically have that property.

Other predicates as you need them.

Example:

Julie's rosebush has purple flowers.
The flowers of rosebushes are many-petalled.
Flowers are pretty.

member(b91, rosebush).
member(b92, person).
name(b92,julie).
owner(b92,b91).
partof(b93,b91).
member(b93,flowers).
hasprop(b93,purple).
partof(roseflowers,rosebush)
subclass(roseflowers,flowers)
hasprop(roseflowers,many-petalled)
hasprop(flowers,pretty).
(end of example)

Desired inferences: Among other things, your system should be able to infer from the above information that (1) the flowers of Julie's rosebushes are many-petalled, (2) part of something Julie owns is purple, (3) typical flowers of rosebushes are pretty, and (4) the flowers of Julie's rosebush are pretty.

It should also be certain which things are classes/typical objects, and which are specific, actual objects. As mentioned in a couple places above, if ambiguities occur, you may need to define separate predicates. The same comment applies to events, which are discussed next.

Your demos should also demonstrate that the system does not infer things that it shouldn't. For example, given the above knowledge, show that the system does not believe that flowers are purple.

1.2 Events = States, Actions, and Happenings

1.2.1 Specific-event predicates

emember(X,Y) means that X is an actual event that is a member of the eventclass Y.

agent(A,E) means that A is the agent of event E

manner(M,E) means that M is the manner in which event E was carried out

day(D,E) means that event E occurred on day D

beneficiary(B,E) means that B is the beneficiary of event E (e.g., For John giving the book to Mary, Mary is the beneficiary)

patient(P,E) means that P is the patient of event E (i.e., the other object besides the beneficiary. For John giving the book to Mary, the book is the patient).

instrument(I,E) means that I is the instrument of event E (e.g., For john weeding the garden with a hoe, the hoe is the instruction).

effect(E1,E2) means that event E2 is an effect of event E1. E.g., an event of the lawn being wet results from an event of the lawn being watered.

Other predicates as needed.

Note that the above are often called "Cases"; all of these pieces of information are together called a case frame. (Charles Fillmore)

1.2.2 Event-Type predicates

subeclass(X,Y) means that eventclass X is a subclass of eventclass Y. For example, mulching is a subclass of improvingTheSoil. Adding organic matter to the soil is also a subclass of improvingTheSoil.

To represent typical knowledge of the agents, instruments, beneficiaries, etc. of events, you can begin by using the predicates defined in the previous subsection. But you may find that you need to define new ones.

Here are examples of inferences your system should be able to make. Suppose your system learns that Julie dug an herbgarden on a particular day, and that it already knows that herbgardens are types of gardens, and that people usually use shovels to dig gardens with. It should be able to answer the question, what instrument did Julie (probably) use to dig the garden? If the system is later told that she used a fencedigger to dig the garden, then the system should no longer give the answer shovel, but should instead answer that she used a fencedigger.

Also, suppose the system knows typical effects of classes of events. It ought to be able to infer from one event occurring that (presumably) the effect event occurred as well.

In addition, your demos should show your system's ability to learn new information about an event it already knows about (e.g., the day or manner). The SNePS demos show ways to give names to nodes (or you can give them names directly yourself). In a realistic system, an outside process would need to establish such correspondences. (We can talk about this in lecture, if there is interest.)

2 Evaluation and What to Hand In

How do you know if your representation is good?

- You can add new information
- Your system can infer what you want it to (even after you add new information)
- Your system does NOT infer something it shouldn't

Many representational issues will come up. Just focus on solving a few non-trivial ones, and simplify the rest.

You should hand in the following:

A "dictionary" listing all of the predicates and the types of arguments they take. Please show the SNePS versions. (20% of your grade).

A set of demos showing the abilities of your system. Please enter sufficient comments to make it clear what the system is doing and what you want it to do (60% of your grade).

A document evaluating the strengths and weaknesses of your system (20% of your grade). Suppose that you are pitching your project as a prototype of a product you will develop for a gardening company. If they hire you, you will first finish extending your representational scheme, and then they will assign a gardening expert to work with you to add all of the specific knowledge that is needed. Please discribe the refinements that would be needed to your representational scheme before you can begin working with the gardening expert. Give some idea of the difficulty of the refinements.

Important: Do NOT use *erase* in your demo.

3 Gardening Knowledge

Here is some knowledge about the gardening domain which you may or may not use. I have written these in English; note that a translation into logic (and SNePS) is likely very different. You will have to simplify things so that you can use a consistent formulation.

If improveTheSoil, plants growing in it will be healthier.
If improveTheSoil, less water will be needed.
If improveTheSoil, less fertilizer will be needed.
If improveTheSoil, earthworms will flourish.

If plants are healthier, the plants will get fewer diseases.

If plants get fewer diseases, fungicides are not needed.

If earthworms flourish, they add castings to the soil.

Mulching, adding organic matter, and growing a green manure crop are ways to improveTheSoil.

compost is organic matter.
manure is organic matter.
straw is organic matter.
hay is organic matter.
leaves is organic matter.
castings is organic matter.

if less water is used, you will save money.
if less fertilizer is used, you will save money.
if less fungicide is used, you will save money.

if less water is used, you will help the environment.
if less fungicide is used, you will help the environment.
if less fertilizer is used, you will help the environment.

Fungicides are used to kill diseases.
Herbicides are used to kill plants.
Pesticides are used to kill insects.

If you mulch the soil, you improveTheSoil.
If you mulch the soil, you suppress weeds.
If you suppress weeds, you don't have to use herbicides.
If less herbicide is used, you will save money.
If less herbice is used, you will help the environment.

If you need some longer lines of reasoning: you can take off on *If you help the environment...*, or *If you save money....*