Module 8

Other representation formalisms

Lesson 21

Frames – II

Version 2 CSE IIT, Kharagpur

Slots as Objects

How can we to represent the following properties in frames?

- Attributes such as *weight, age* be attached and make sense.
- Constraints on values such as *age* being less than a hundred
- Default values
- Rules for inheritance of values such as children inheriting parent's names
- Rules for computing values
- Many values for a slot.

A slot is a relation that maps from its domain of classes to its range of values.

A relation is a set of ordered pairs so one relation is a subset of another.

Since slot is a set the set of all slots can be represent by a metaclass called *Slot*, say.

Consider the following:

```
SLOT
                isa:            Class
                instance:               Class
                domain:
                range:
                range-constraint:
                definition:
                default:
                to-compute:
                single-valued:


Coach
                instance:               SLOT
                domain:                 Rugby-Team
                range:                  Person
```

range-constraint: λx *(experience x.manager)*

default:

single-valued: *TRUE*

Colour

instance: *SLOT*

domain: *Physical-Object*

range: *Colour-Set*

single-valued: *FALSE*

Team-Colours

instance: *SLOT*

isa: *Colour*

domain: *team-player*

range: *Colour-Set*

range-constraint: *not Pink*

single-valued: *FALSE*

Position

instance: *SLOT*

domain: *Rugby-Player*

range: *{ Back, Forward, Reserve }*

to-compute: λx *x.position*

single-valued: *TRUE*

NOTE the following:

- Instances of *SLOT* are slots
- Associated with *SLOT* are attributes that each instance will inherit.

- Each slot has a domain and range.
- Range is split into two parts one the class of the elements and the other is a constraint which is a logical expression if absent it is taken to be true.
- If there is a value for default then it must be passed on unless an instance has its own value.
- The *to-compute* attribute involves a procedure to compute its value. *E.g.* in *Position* where we use the dot notation to assign values to the slot of a frame.
- Transfers through lists other slots from which values can be derived

Interpreting frames

A frame system interpreter must be capable of the following in order to exploit the frame slot representation:

- Consistency checking -- when a slot value is added to the frame relying on the domain attribute and that the value is legal using range and range constraints.
- Propagation of *definition* values along *isa* and *instance* links.
- Inheritance of default. values along *isa* and *instance* links.
- Computation of value of slot as needed.
- Checking that only correct number of values computed.

Access Paths

One advantage of a frame based representation is that the (conceptual) objects related to a frame can be easily accessed by looking in a slot of the frame (there is no need, for example, to search the entire knowledge-base). We define an *access path*, in a network of frames, as a sequence of frames each directly accessible from (*i.e.* appearing in a slot of) its predecessor. A sequence of predicates defines an access path iff any variable appearing as the first argument to a predicate has appeared previously in the sequence. For example, ``John's parent's sister'' can be expressed in Algernon as the path:

```
((parent John ?x) (sister ?x ?y))
```

The access path `((parent John ?x) (sister ?x ?y))` is equivalent to the syntactically similar predicate calculus statement:

$$parent(John, ?x) \wedge sister(?x, ?y).$$

In predicate calculus this statement is equivalent to

$$sister(?x, ?y) \wedge parent(John, ?x).$$

However, the corresponding sequence of predicates:

```
((sister ?x ?y) (parent John ?x))
```

is *not* an access path because a query of `(sister ?x ?y)` requires a search of every frame in the entire knowledge-base.

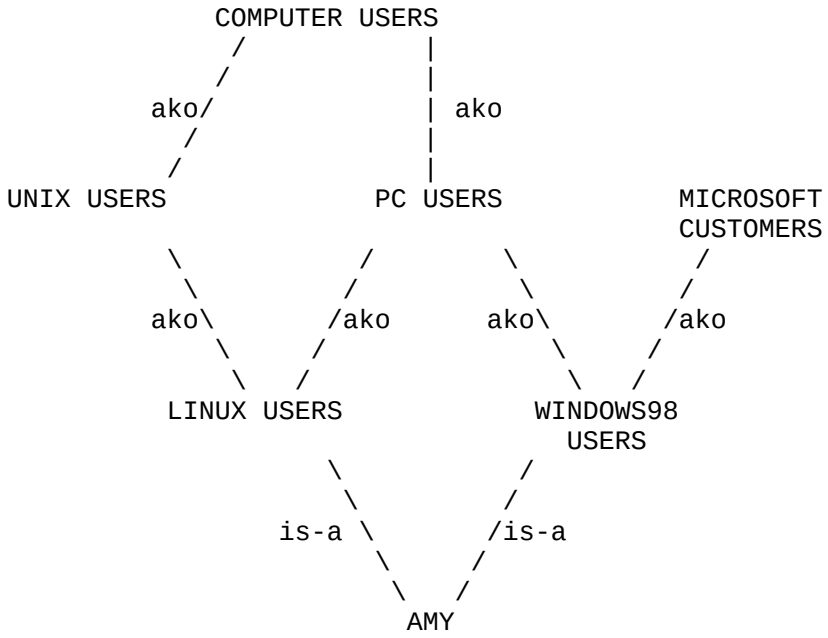
Questions

1. Construct semantic network representations for the information below.

a. Richard Nixon is a Quaker and a Republican. Quakers and Republicans are Persons. Every Quaker every quaker follows the doctrine of pacifism.

b. Mary gave the green flowered vase to her cousin.

2. Consider the following hierarchy of frames.



a. Give the class-precedence list for Amy that would be obtained by applying the topological-sorting algorithm to the above graph.

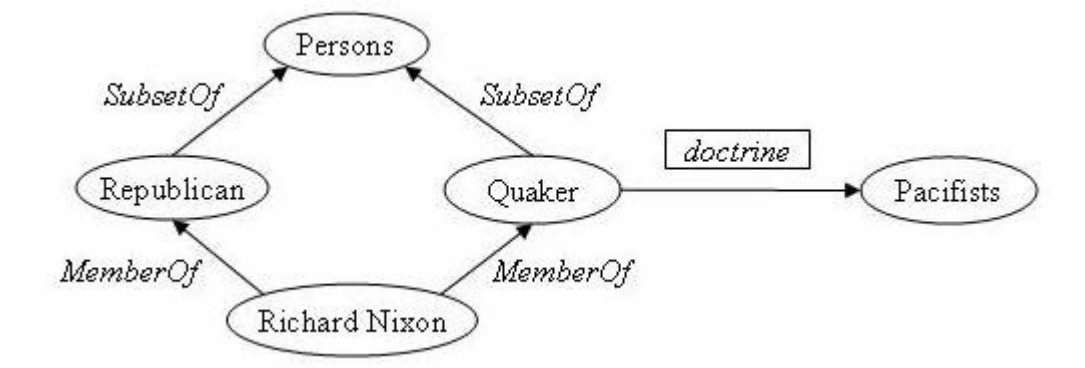
b. Suppose that each of the classes *Unix users, PC users* and *Computer Users* contains a *favorite programming language* slot. The default value for this slot is:

- Fortran, for the *Computer Users* class.
- C, for the *Unix Users* class.
- C++, for the *PC Users* class.

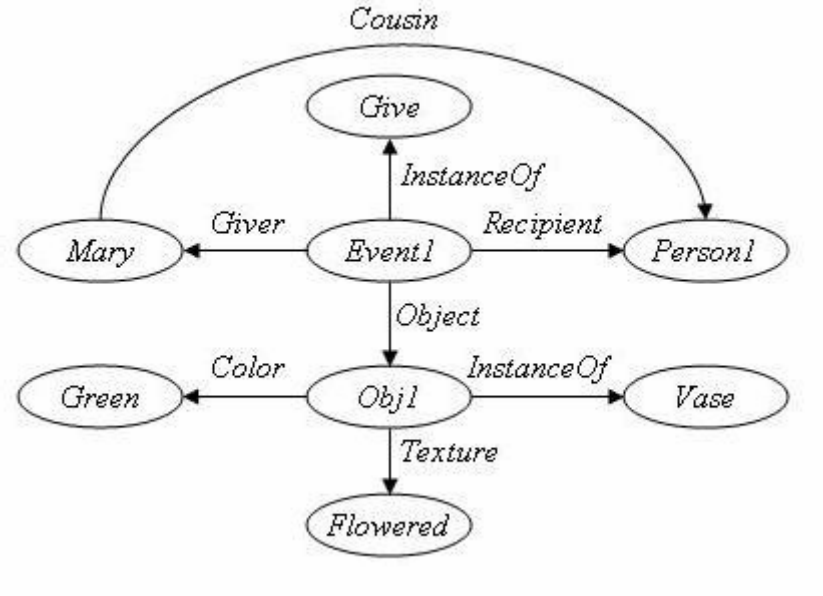
What is the value obtained for Amy's favorite programming language according to the class-precedence list you constructed above?

Solutions

1.a



1.b



2.a.

Node	Fish-hook pairs
Amy	Amy-Linux Users, Linux Users-Windows98 Users
Linux Users	Linux Users-Unix Users, Unix Users-PC Users
Windows98 Users	Windows98 Users-PC Users, PC Users-Microsoft Customers
Unix Users	Unix Users-Computer Users
PC Users	PC Users-Computer Users

Class Precedence list :

Amy
Linux Users
Unix Users - Use C
Windows98 Users
PC Users - Use C++
Computer Users - Use Fortran
Microsoft Customers

1. Amy's favorite programming language is C