Project 3
An Automated Homicide Detective in SNePSLOG
CSE 4/563, Knowledge Representation
Due Thursday, December 10, 2009

Professor Shapiro

November 17, 2009

1 Project Statement

You are to use the SNePSLOG interface to SNePS to solve the following puzzle:

"One evening there was a murder in the home of [a] married couple, their son and daughter. One of these four people murdered one of the others. One of the members of the family witnessed the crime.
The other one helped the murderer.
These are the things we know for sure:

1. The witness and the one who helped the murderer were not of the same sex.

2. The oldest person and the witness were not of the same sex.

3. The youngest person and the victim were not of the same sex.

4. The one who helped the murderer was older than the victim.

5. The father was the oldest member of the family.

6. The murderer was not the youngest member of the family.

Who was the murderer?" [1]

2 Discussion

Notice that although there are only four different people involved, information is given about

1. "the oldest person",
2. "the witness",
3. "the youngest person",
4. "the victim",
5. "the one who helped the murderer",
6. "the father",
7. "the oldest member of the family,"
8. "the murderer",
9. "the youngest member of the family".

That is, there are only four actual people, but twelve intensional people:

Suspects: the Father, the Mother, the Son, the Daughter;

Roles: the murderer, the helper, the victim, the witness;

Family Positions: the oldest, the nextoldest, the nextyoungest, the youngest.

The mystery is solved when we know which of the Father, the Mother, the Son, or the Daughter the murderer is coreferential with. If we use the SNePSLOG proposition, `Equiv({x,y})` to mean "[x] and [y] are coreferential", the puzzle may be solved by answering the question, "`Equiv({murderer,?x})?`" as long as that answer mentions the Father, the Mother, the Son, or the Daughter.

Andri, the poser of the puzzle, provides the following suggestion,

> "Establish what we know about the youngest person first. This person cannot have been either the victim [(3)], the helper [(4)] or the killer [(6)]. Then work out who was oldest, youngest, etc. After this draw up the various possibilities about who could have been what." [1]

Andri also provides an analysis that includes the answer, and a way to reason to the answer:

> "We know from (3) that the youngest person was not the victim, from (4) that the youngest person was not the helper and from (6) that the youngest person was not the killer. The youngest person can only have been the witness therefore. If we make up a chart there are now three possible combinations:
>
> | | | | |
> |---|---|---|---|
> | Oldest person (father) | H | H | M |
> | Next to oldest (mother) | V | M | H |
> | Next to youngest (son) | M | V | V |
> | Youngest (daughter) | W | W | W |
>
> (H = Helper ; V = Victim ; M = Murderer ; W = Witness)
> We can work out from (5) that the father was the oldest, from (2) that the youngest person must have been the daughter. Therefore the next to the youngest must have been the son and the next to the oldest, the mother.
> Of three possibilities: the first is impossible (from (3) — the youngest person and the victim were of different sexes); the third is also impossible (from (1) — the witness and the helper were of different sexes). Therefore only the second possibility holds — and the mother was the murderess." [1]

You should treat the analysis as a hint about the information you need to provide the reasoning system, and as a suggestion about some subquestions to ask. Here are some more:

- You need to provide an axiom about the transitivity of `Equiv`. That is, if two entities are coreferential with a third, they are coreferential with each other.

- You'll need to tell the reasoner that each suspect has one and only one role, and that each position (oldest, nextoldest, nextyoungest, youngest) has one and only one role.

- You'll need to tell the reasoner that everyone is either male or female, but not both.

- You'll need to tell the reasoner that the sex of two coreferential entities is the same.

- You may assume, and tell the reasoner, that the father and son are male, and that the mother and daughter are female.

- You may assume, and tell the reasoner, that the father and and mother are both older than the son and the daughter.

- You will need to assert SNePSLOG formulas that express some of the same information that appears in Andri's analysis above. These may facts that you just assume, but that you have to tell the reasoner. Like in Project 2, do not include wffs that are overly specific, and amount to simply stating the solution.

- Once your reasoner identifies the murderer, you may go into the SNePSLOG `expert` mode, look at the origin set, and create a file with only the hypotheses actually needed to solve the puzzle. If you do this, you are encouraged to submit just that minimal file as your "program." You should, of course, describe in your report how and that you did this.

- Remember that SNePS treats wffs like `P() => Q()` as directions to reason from `P()` to `Q()`, not from `Q()` to `P()`, nor from ~`P()` to ~`Q()`, nor even from ~`Q()` to ~`P()`.

3 Deliverables

As it says on the CSE 4/563 web page, you are to

> "hand in a paper, produced using a document formatting program such as LaTeX or Microsoft Word, and printed on 8.5 by 11 inch paper, stapled in the upper left-hand corner, with a title, your name(s), user name(s), and other identifying information at the top of the first page (Do not use the header page automatically produced by the printer), plus a well-documented listing and run of your program. (Do not enclose your paper in a folder or cover.)" [5]

The paper is due at the start of class on the date shown at the beginning of this document.

In addition to the paper, you are to `submit` (using `submit_cse463` or `submit_cse563`) your program, so that it can be run and checked if the instructors choose. Name your file `proj3KB.snepslog`. You are to submit your KB file by one half-hour before the start of class on the date shown at the beginning of this document, so that you can get to class on time to hand in the paper.

Your KB file is to include English and SNePSLOG versions of the formalization of your domain, and of the query (or queries).

Remember that **you will only get credit for what you discuss and show in your paper**. The KB file will only be looked at if the grader suspects that the claims in your paper might exceed what the "program" actually does.

3.1 The Paper

Your paper should have the following parts:

1. Descriptive title

2. Name(s) and user name(s) of author(s)

3. Introduction: general description of the project

4. Domain and Knowledge Base

   (a) Syntax and semantics of atomic symbols
   (b) English and formal presentation of the KB.

5. Demonstration run, properly commented and formatted

6. Acknowledgments as needed

7. References as needed

4 Grading

Project grading will be according to the following table.

	CSE 463	CSE 563
KB		
Puzzle statements (1)–(6) (6 × 2)	12	12
The three groups of intensional entities (3 × 2)	6	3
Transitivity of `Equiv`	2	1
Each suspect has one and only one role	2	1
Each position has one and only one role	2	1
Everyone is either male or female, but not both	2	1
The sex of two coreferential entities is the same	2	1
The father and son are male; the mother and daughter are female	2	1
The father and and mother are both older than the son and the daughter	2	1
Additional information	24	24
KB Subtotal	**56**	**46**
Solution*		
Identification of the murderer	24	24
Or for partial solution		
Identification of the witness	6	6
Identification of the helper	6	6
Identification of the victim	6	6
Questions Subtotal	**24**	**24**
Paper		
Paper format	2	3
General project description	2	3
English description of KB	5	7
Presentation of syntax and semantics of atomic symbols	5	7
Formatting & presentation of demonstration run	3	5
Correct use of quotation and citations	2	3
Acknowledgments and References	1	2
Paper Subtotal	**20**	**30**
Project Total	**100**	**100**

*Identification means identification of the role with either the Father, Mother, Son, or Daughter.

References

1. Andri, The murder (Logic Brainteaser Puzzle), `http://brainteaser-puzzles.blogspot.com/search/label/The murder (Logic Brainteaser Puzzle)`.